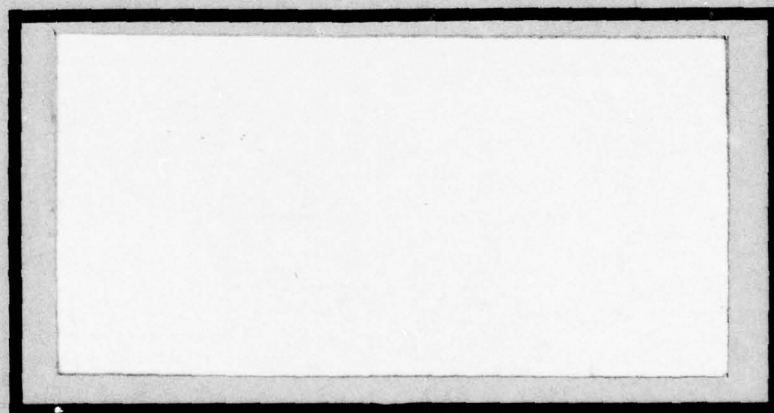
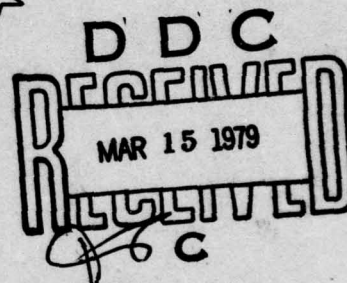


AD A0 65970

DDC FILE COPY

LEVEL II



UNITED STATES AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY
Wright-Patterson Air Force Base, Ohio

This document has been approved
for public release and sale; its
distribution is unlimited.

70 03 14 025

AD A0 65970

DDC FILE COPY

12

DDC
RECEIVED
MAR 15 1979
C

A SYSTEM DYNAMICS MODEL OF THE
DEPARTMENT OF DEFENSE ENLISTED FORCE
FOR INVESTIGATION OF ALTERNATIVE RETIREMENT
PROPOSALS

THESIS

AFIT/GOR/SM/78D-2

John W. Bell, Jr.
CAPT USAF

Robert E. Liphard
CAPT USAF

This document has been approved
for public release and sale; its
distribution is unlimited.

79 03 14 025

14

AFIT/GOR/SM/78D-2

6

A SYSTEM DYNAMICS MODEL OF THE
DEPARTMENT OF DEFENSE ENLISTED FORCE
FOR INVESTIGATION OF ALTERNATIVE RETIREMENT
PROPOSALS.

9

Master's
THESIS,

Presented to the Faculty of the School of Engineering
of the Air Force Institute of Technology
Air Training Command
in Partial Fulfillment of the Requirements
for the Degree of Master of Science

12

179 p.

by

10

John W. Bell, Jr.
~~Captain~~ ~~USAF~~

Robert E. Liphard
~~Captain~~ ~~USAF~~

11

December 1978

Approved for public release; distribution unlimited

012 225

slf

Preface

Demands to change the military retirement system are regularly brought before Congress and the Department of Defense (DOD). Proposals ensuing from these demands generate analyses to establish the cost effectiveness of a particular retirement plan. A fundamental oversight in most of these analyses is that any change in the retirement system is likely to produce profound effects on other parts of the personnel system. To obtain a full assessment of the marginal cost of changes in the retirement program, total system costs must be evaluated, not just retirement costs alone.

The analysis set forth in this report applies the system dynamics methodology to construct an aggregate model of the Department of Defense enlisted personnel system. System dynamics allows investigation of such a complex system by providing techniques for approximating the interactions that occur between the various components of that system.

Several people provided us with valued assistance in helping us complete this thesis. We would like to thank Captain Jon Knight, our advisor, for his priceless guidance and instruction. Major Ralph Praeger of the Office of the Assistant Secretary of Defense also provided us with helpful advice and comments. From that same office we would like to thank Sergeant Terry Wisener who provided us with valuable data necessary to the accuracy of this report. AFOSR supported the procurement of the DYNAMO IIIF compiler and remote terminal used in the course of the project.

in the course of the

ACCORD TO THE
WIS
002
WING-WORD
I S I SECTION
A
BY
DATE
OCT 1963
A

We would like to mention Captains Michael F. Carpenter and Michael R. Lacey whose thesis provided us a general framework and gave us some insights into the nature of the military personnel system.

John W. Bell, Jr.

Robert E. Liphard

A very special thanks must be given my wife, Charlotte, without whose patience and understanding this thesis would never have been completed.

John W. Bell, Jr.

Table of Contents

	<u>Page</u>
Preface	ii
List of Figures	vi
List of Tables.	ix
Abstract.	x
I. INTRODUCTION.	1
The Retirement Issue.	1
The Purpose of the Thesis	2
Scope of the Thesis	3
II. THE PERSONNEL SYSTEM.	4
The Nature of the System.	4
Enlistments	5
Reenlistments	8
Promotions.	8
Attritions.	9
TOPCAP.	10
III. RETIREMENT SYSTEM AND ISSUES.	15
The Present Retirement System	15
Retirement Plan Submitted by the President's Commission	17
IV. THE MODEL	19
The Approach.	19
Management Decision Making.	21
Accessions.	21
Promotions.	22
Attritions.	22
The Model Design.	23
Using the Model	27
V. ANALYSIS OF THE PRESIDENT'S COMMISSION PROPOSAL	29
Bibliography.	36
APPENDIX A: The System Dynamics Methodology.	38
APPENDIX B: Model Documentation.	42
APPENDIX C: Costing.	87

	<u>Page</u>
APPENDIX D: Model Validation	103
APPENDIX E: Analysis Output.	128
APPENDIX F: Computer Program Listing	151
Vitae	165

List of Figures

<u>Figure</u>		<u>Page</u>
1	TOPCAP Grade Structure	12
2	Pay Feedback Loop.	20
3	Multiplier for Military Pay.	26
A-1	System Dynamics Model.	40-A
A-2	Rate Equation.	41
B-1	Grade/Year Category Array.	46
B-2	Model Flow Chart	48
B-3	Gains Array.	50
B-4	Losses Array	53
B-5	Enlistment Management Multiplier	59
B-6	Multiplier for Unemployment Rate	61
B-7	Supply Wage Multiplier	62
B-8	Multiplier From Promotion Opportunity.	67
B-9	Responsiveness of Military Pay to Voluntary Separations.	71
B-10	Multiplier From Military Pay (ATTMP)	72
B-11	Multiplier From Management Policy.	75
B-12	Retirement Multiplier.	85
D-1	Enlisted Force Equilibrium (Grades E1 - E4).	114
D-2	Enlisted Force Equilibrium (Grades E5 - E9).	115
D-3	Force Drawdown; Grade Distribution E1 - E4	116
D-4	Force Drawdown; Grade Distribution E5 - E9	117
D-5	Force Drawdown; Career and Total Force	118
D-6	Force Drawdown; Attritions, Enlistments, Promotions, and Retirements.	119

<u>Figure</u>		<u>Page</u>
D-7	Decreased Enlistments; Attritions, Enlistments, Promotions, and Retirements	120
D-8	Decreased Enlistments; Grades E1 - E4	121
D-9	Decreased Enlistments; Grades E5 - E9	122
D-10	Decreased Enlistments; Career and Total Force	123
D-11	Increased Attritions; Accessions, Enlistments, Promotions, and Retirements	124
D-12	Increased Attritions; Grades E1 - E4.	125
D-13	Increased Attritions; Grades E5 - E9.	126
D-14	Increased Attritions; Career and Total Force.	127
E-1	Enlisted Force Equilibrium (Grades E1 - E4) under the Present System and the Commission System With No Change in Attrition Rates	130
E-2	Enlisted Force Equilibrium (Grades E5 - E9) under the Present System and the Commission System With No Change in Attrition Rates	131
E-3	Equilibrium Enlistments, Promotions, Attritions, and Retirements Under the Present System and the Commission System With No Change in Attrition Rates . .	132
E-4	Equilibrium Total Force and Career Force Under the Present System and the Commission System With No Change in Attrition Rates	133
E-5	Costs Under the Present System in Equilibrium	134
E-6	Costs Under the Commission System in Equilibrium With No Change in Attrition Rates	135
E-7	Grades E1 to E4 Under Low Intended System Response. . .	136
E-8	Grades E5 to E9 Under Low Intended System Response. . .	137
E-9	Total Enlistments, Promotions, Attritions, and Retirements Under Low Intended System Response.	138
E-10	Total Force and Career Force Under Low Intended System Response	139
E-11	Costs Under Low Intended System Response.	140

<u>Figure</u>		<u>Page</u>
E-12	Grades E1 to E4 Under Moderate Intended System Response	141
E-13	Grades E5 to E9 Under Moderate Intended System Response	142
E-14	Total Enlistments, Promotions, Attritions, and Retirements Under Moderate Intended System Response. . .	143
E-15	Total Force and Career Force Under Moderate Intended System Response.	144
E-16	Costs Under Moderate Intended System Response.	145
E-17	Grades E1 to E4 Under High Intended System Response. . .	146
E-18	Grades E5 to E9 Under High Intended System Response. . .	147
E-19	Total Enlistments, Promotions, Attritions, and Retirements Under High Intended System Response.	148
E-20	Total Force and Career Force Under High Intended System Response.	149
E-21	Costs Under High Intended System Response.	150

List of Tables

<u>Table</u>		<u>Page</u>
I	Projected Female Nonprior-Service Enlistments	7
II	Projected High School Graduate Enlistments.	7
III	Promotion Phase Points and Promotion Opportunity.	13
IV	TOPCAP Promotion Eligibility Windows to Next Higher Grade and High Year of Tenure (HYT) for Each Grade. . . .	13
V	Estimated Cost Implications of the President's Commission Compensation Proposal	34
C-I	Standard Pay Rates.	90
C-II	Years of Service and Basic Pay for Retirement Computation	92
C-III	Eligibility for Retirement Annuity.	94
C-IV	Annuity Multipliers	94
C-V	Government Contribution to Deferred Compensation Account.	98
D-I	Output Interpretation for Test Cases.	109

Abstract

Several proposals to restructure the military retirement system have been placed before Congress and the Department of Defense. In order to evaluate the cost effectiveness of these retirement proposals each alternative must be considered in view of its impact on the entire personnel system. Consideration should be given to impacts on the force profile as well as to cost implications which result from changes in military compensation policies. Complex interactions occur in the personnel system which require a thorough understanding and investigation by force managers. This report develops a dynamic model of the Department of Defense enlisted personnel system which facilitates that type of examination. Analysis of the most recent retirement proposal, submitted by the President's Commission on Military Compensation, indicates substantial savings could be realized under full implementation of the plan.

A SYSTEM DYNAMICS MODEL OF THE
DEPARTMENT OF DEFENSE ENLISTED FORCE FOR
INVESTIGATION OF ALTERNATIVE RETIREMENT PROPOSALS

I. Introduction

The Retirement Issue

Congress, the Department of Defense (DOD), and the President have all been giving increased attention to proposals for restructuring the military retirement system. Focus on this issue is due primarily to what is perceived to be an alarming increase in military personnel expenditures. In 1979, active duty compensation will cost the Department of Defense almost \$41 billion. Of that cost, approximately \$10 billion will be retirement pay (Ref 1:25).

Several proposals which call for a reduction in retirement pay expenditures have been placed before Congress and the DOD. As noted in the thesis by Carpenter and Lacey, "the basic problem is that the potential benefits from reduced retirement outlays will most likely be realized only at some cost to the personnel system in general. For example, decreased retirement payments may be reflected in increased recruitment costs, higher turnover (which increases training costs), and/or decreased quality in the personnel. This type of cost-benefit trade-off makes the comparison of alternative retirement schemes an exceedingly complex effort. In some cases, proponents of the proposals have attempted to provide some very general estimates of the total impact, but the conflicting assumptions and data make comparison of the various plans difficult. The more cost-effective retirement system would be that one

which reduces the DOD budget the most (assuming, of course, that mission performance is not degraded), not necessarily the one which reduces retirement costs the most (Ref 2:1-2)."

The Purpose of the Thesis

The purpose of this thesis is to construct a system dynamics model of the enlisted personnel system which allows investigation of the effects of alternate retirement proposals on that system. The report of the President's Commission on Military Compensation, completed in April 1978, contains the most recent analysis and proposal for change in the retirement system. In order to compare the Commission's system and the present system, a model was developed which simulates the Department of Defense enlisted force structure.

The model is a system dynamics representation of the aggregate DOD enlisted force. It is important to note that the DOD was considered to have a single enlisted force structure regulated by a single set of goals and policies. In reality, each branch of service (Air Force, Army, Navy, and Marines) is given the latitude (within certain guidelines) to develop and manage its own personnel system. A more valid cost comparison for the entire DOD force would be obtained by evaluating alternate retirement scenarios for each service and summing the total costs. Nonetheless, the personnel system of each service was considered to possess a degree of homogeneity sufficient to allow aggregation without masking the cost implications of changing the retirement alternative. The model incorporates objectives and policies contained in the U.S. Air Force Total Objective Plan for Career Airman Personnel (TOPCAP). The simulation is designed to track force structure evolution under different compensation policies and environmental scenarios, and to analyze cost implications

of both transient and equilibrium effects caused by policy changes. The model was not structured to predict the actions of individual personnel or to accurately measure point estimates of the costs of the two different retirement systems.

Scope of the Thesis

The model constructed in this thesis is basically a representation of the personnel enlistment policy, the promotion system, the career force structure, the retirement policy, and a cost module for measuring and accumulating costs generated by the system. Because of the importance of understanding the personnel system and how it is affected by the retirement issue, Chapter II will be devoted to a discussion of the dynamics of that system. Chapter III describes the current retirement system, and the retirement proposals submitted by the President's Commission. Chapter IV contains a brief discussion of the model and some of the major assumptions and behavioral hypotheses used in the analysis. A detailed description of specific equations is presented in the appendices. Finally, Chapter V contains results and conclusions.

II. The Personnel System

As mentioned earlier, the personnel system to be discussed in this report addresses the management of the enlisted personnel of the entire Department of Defense. Though the systems of the four services are slightly different, the nature of the systems remain virtually identical. This nature allows an analysis of basic trends and effects caused by changes in policy introduced into the aggregate dynamic enlisted force.

The Nature of the System

Enlisted personnel carry out the mission of the DOD in an environment involving their jobs, external labor markets, and a set of administrative policies regulating their enlistment, attrition, retirement, promotion, and movement. The reactions of the personnel to the environment and to changes in the environment produce the dynamic nature of the system.

To perform the mission of the DOD, the personnel force managers must insure that the required quantity and quality of human resources are available. The method used to attain this goal is to manage the force using a specific force profile defined by Congressional authorizations. A force profile consists of the desired number of personnel in each of the grades as well as the distribution by years of service (YOS) of the personnel in each grade. The shape of the force profile is a function of Congressional authorized total force strength, and grade ceilings, as well as DOD recognized career force and grade ceiling objectives.

Personnel enter the force primarily through a single point of entry in the grade of E-1 and are aged and promoted through the system.

The shape of the force profile is regulated by several functional categories of personnel management decisions dealing with such things as accessions, reenlistments, promotions, and attritions. Because the decisions (which are often made independently) interact with one another, it is not always obvious what the final shape of the force will be. Moreover, the force profile is affected by factors which are not controllable by personnel managers. Such factors include military pay, unemployment rates, the size of age cohorts in the population, and public attitudes toward the military. Military pay can be adjusted by Congress, but the other factors must be considered exogenous to the system. When a perceived discrepancy exists in the objective force profile, personnel management options are constrained by policies over which they have control.

The actual force profile is a function of inflows (accessions), through-flows (reenlistments and promotions), and outflows (attrition). In order to control the force profile, managers must work with the accession, reenlistment, promotion, and attrition policies. Each of these policies will be described in further detail below.

Enlistment Policy (Accessions)

The purpose of the enlistment policy is to replace the losses from the force and to procure personnel to adjust total force levels to some force strength goal. Implicit in replacing losses from the force is the goal of accessing the required number of individuals to maintain the size of the career force (the nature of the career force will be discussed later). The number of enlistments is a function of the DOD demand and the supply of the labor market. Population decline, quality restrictions, and recruiting market penetration are but a few of the

factors which serve to influence the enlistment supply. There is some concern among the services that this supply will not be sufficient to meet future enlistment goals. The decline in the 17-21 year old male population pool is the primary reason for this concern.

It appears that the Department of Defense is faced with the following alternatives (in terms of supporting the all-volunteer force) in overcoming the possible enlistment shortfall:

- (1) Decrease the objective force size (or be willing to operate below authorized strength).
- (2) Increase the procurement of prior service personnel.
- (3) Increase the quantity of enlistees who do not meet desired quality goals.
- (4) Increase the number of female procurements.
- (5) Request increases in perceived military benefits (i.e., military pay, bonuses).

There is currently an effort in the DOD to determine the number of jobs that could successfully be accomplished by women. In 1978, 38,302 women were recruited into the services. Table I reflects the projected non-prior service female enlistment goals for the next six years (Ref 3).

Presently, 87.8 percent of the entire enlisted force are high school graduates (some received their diplomas after entering the service). There is some indication that those individuals possessing high school diplomas not only function better in the military environment, but also tend to remain in the service for longer periods of time (Ref 4:5). This increased retention reduces the system cost. The DOD expects to be able to enlist high school graduates according to the percentages of the total enlistments listed in Table II (Ref 3).

TABLE I

Projected Female Nonprior Service Enlistments
(Expressed as a percentage of total enlistments)

<u>Year</u>	<u>Percent</u>
1979	12.4
1980	13.0
1981	14.6
1982	15.7
1983	16.4
1984	14.9

TABLE II

Projected High School Graduate Enlistments
(Expressed as a percentage of total enlistments)

<u>Year</u>	<u>Percent</u>
1979	78.8
1980	74.4
1981	75.0
1982	75.3
1983	76.3
1984	75.3

If the DOD can fulfill its mission by choosing any (or all) of the first four alternatives, there will be little difficulty in meeting accession requirements.

In order to attract people into the military, each service conducts its own recruiting program. Advertising, as well as direct contact through recruiters, are the primary means of attracting potential enlistees. An estimated 12,300 individuals were directly involved in the program in 1978 (Ref 3). Because the cost of recruiting and training new personnel is high, it is desirable to keep the number of accessions to the necessary minimum.

Reenlistment Policy

The enlisted force has two major components--the career force and the first term force. The career force serves as an experience pool--the hub of the enlisted work force. The objective of the reenlistment policy is to flow the proper quantity of personnel into the career force that will sustain the desired career force age and grade structure. The size of the career force is a function of the size of the total force. The exact number of personnel in the career force is determined by force managers and is based on skill level requirements by job specialty codes (Ref 5:C-1).

Force managers use the reenlistment policy to flow personnel into the career force, or out of the system, depending on the discrepancy in the force profile.

Promotion Policy

The function of the promotion policy is to assure that there are the required number of personnel in each grade necessary to carry out

the force mission. "Enlisted grades furnish a means of distinguishing leadership and supervisory levels in ascending progression and provide the necessary capability to support mission requirements. The grades also provide a basis for compensation, and must be structured to help provide for the highest possible level of motivation." (Ref 5:B-9). Promotion policies are the means of filling the grades and of modifying or maintaining the shape of the force grade profile. Promotion policy is restricted to some degree by grade ceilings established by Congress. Ceilings exist for the grades of E-8 and E-9 so that promotions cannot occur to these grades unless there is a vacancy. The force managers can determine promotion policy to the other grades and can also determine the phase points and promotion opportunity to every grade category. This authority gives the personnel managers some flexibility in altering the force profile, although they must do it subject to overall manpower and budget ceilings.

Attrition Policy

Attrition is the only means of leaving the personnel system. It includes such components as death, retirement, voluntary separation, involuntary separation, and disciplinary discharge. Some types of attrition are controllable while others are not. Moreover, some types of attrition are desirable. If every person that enlisted in the force chose to stay, either retirement costs would be extremely high or a large number of people would be forced out involuntarily. The force would age to the detriment of the mission of the DOD. Neither of these conditions is desirable.

The most important type of attrition from the manager's point of

view is voluntary separation. Voluntary separation can occur anytime from the completion of initial enlistment to the 30 year point. (Presently, separations after 20 years of service are actually retirements.) The decision to separate is a function of many variables, including personal preferences, but it is a reasonable assumption that voluntary separation will be affected by certain changes in personnel policy. Changes in military pay, promotion opportunity, and retirement benefits are examples of such policy changes.

Involuntary separations can also be used by force managers to alter or maintain the force profile. Such separations currently occur at the reenlistment points (particularly at the career entry decision point). Involuntary separations in the enlisted force will be at a minimum in a stable force condition if other personnel policies are administered properly. In the future, if and when enlisted personnel are given readjustment pay for involuntary separation, it will be even more desirable to minimize forced separations.

TOPCAP

As was mentioned earlier, the blueprint for the personnel system used in this report is the Air Force TOPCAP program. The specific objectives of TOPCAP are (Ref 6:1-1):

- (1) Establish a stable career configuration for each enlisted occupation that combines to form a total force that meets peacetime as well as limited force expansion requirements.
- (2) Provide a baseline of active force capabilities for general mobilization.
- (3) Provide a visible career pattern that will enhance accession and retention of high caliber personnel.
- (4) Establish an integrated management system which provides

- (a) Equitable promotion opportunity for all airmen.
- (b) A control process for regular and systematic progression through pay grades in each occupation.
- (c) A basis for purposeful application of monetary incentives.

The TOPCAP force consists of two components--the first term force and the career force. Personnel with less than four years of active service are considered first term. Those having over four years of service and serving on their second enlistment are considered to be part of the career force. People can enlist into the TOPCAP force for periods of two through six years (those who initially enlist for periods over four years are not considered part of the career force until they are allowed to reenlist). The size of the career force is dependent on the total force size, and is a function of the number of supervisory level jobs required to meet mission objectives. While the exact number changes, the percent of the total force that is career remains fairly stable.

The objective grade structure is shown in Figure 1. The Congressionally limited ceilings for E-8's and E-9's are 2 and 1 percent of the total force, respectively. Objective percentages for grades E-4 through E-7 also exist. When the force is in the objective configuration, promotion phase points and promotion opportunity for the top six grades will equal the values shown in Table III (Ref 5:B-9).

In order to maintain the desired force profile, certain promotion policies will be followed. Promotions to grades E-2, E-3, and E-4 will be on a fully qualified basis. Promotion to grades E-5 through E-9 will be the best qualified to a vacancy. The promotion eligibility windows, by years of service, are shown for each grade in Table IV. Should a

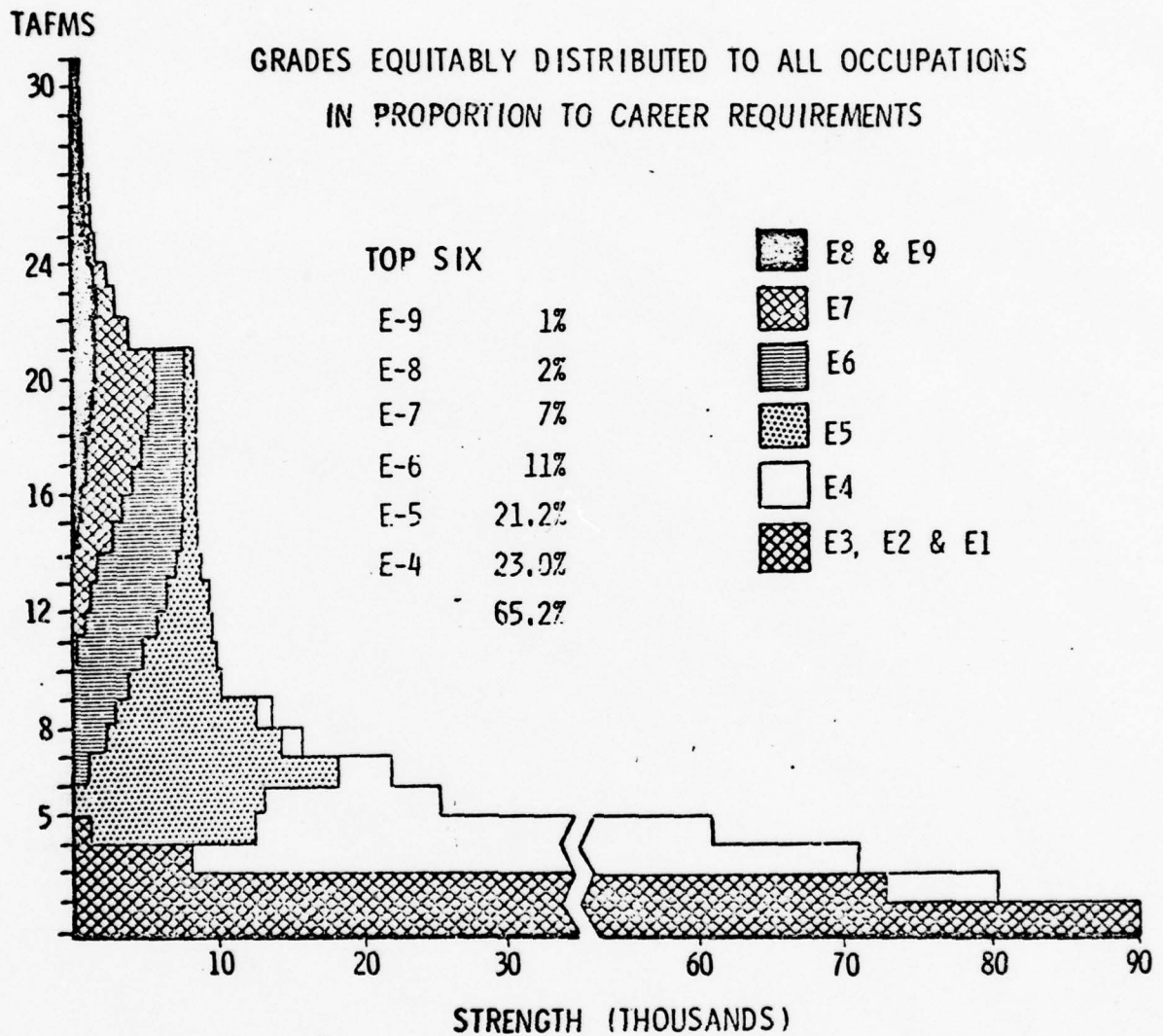


Figure 1. TOPCAP Grade Structure

TABLE III

TOPCAP Top Six Grade Standards

E-9	22.5	60%
E-8	20.0	75%
E-7	15.7	84%
E-6	10.4	90%
E-5	4.3	90%
E-4	2.7	98%

TABLE IV

TOPCAP Promotion Eligibility Windows to Next Higher Grade and High Year of Tenure (HYT) for Each Grade

<u>To Grade</u>	<u>Promotion Eligibility Period</u>	<u>HYT</u>
E-9	14-27 Years	30 Years
E-8	11-24 Years	28 Years
E-7	8-21 Years	26 Years
E-6	5-19 Years	23 Years
E-5	3-7 Years	20 Years
E-4	Fully Qualified	8 Years
E-3	Fully Qualified	4 Years

person not be promoted within the promotion eligibility period, he is forced to leave the system upon reaching the prescribed high year of tenure (HYT, Table IV). The TOPCAP high year of tenure for E-4's is currently 20 years. When enlisted readjustment pay is enacted (this was suppose to occur in 1978, but thus far it has not been passed by Congress),

the E-4 HYT will be lowered to 8 years. According to TOPCAP planners, the costs of keeping and retiring personnel who have not been promoted to E-5 by their eighth year currently far exceeds the costs of procuring and training replacements (Ref 5:B-14). The TOPCAP HYT for each grade is a policy designed to control the size of the career force and to prevent promotion stagnation.

III. Retirement System and Issues

The Present Retirement System

Since the purpose of this analysis is to build a model which will allow evaluation of alternative retirement plans, the current retirement system should be understood. This chapter outlines the major points of the present system as well as the portion of the President's Commission on Military Compensation relevant to retirement and the current military compensation system. The discussion pertains only to nondisability retirement.

The current retirement system is the result of legislation enacted in the late 1940's. The basic provisions call for voluntary retirement between 20 and 40 years of service at the discretion of the Secretary of the Military Department, not at the discretion of the individual (Ref 2: 17). Military retirement, however, has come to be viewed as a contracted right by most service personnel. The retirement annuity is computed by multiplying the member's annual basic pay at retirement by $2\frac{1}{2}$ percent of his years of service. After retirement, annuities are periodically adjusted upward to keep pace with increases in the cost of living as measured by the consumer price index (CPI). The annuity is paid upon retirement and ceases at the retiree's death.

Much of the attention given to retirement has arisen because of the spiraling costs of retired pay. In fiscal year 1964, retired pay amounted to \$1.2 billion; in fiscal year 1978, retired pay outlays are estimated at \$9.2 billion. The fiscal year 1978 figure represents 8 percent of the defense budget compared with 2 percent in fiscal year 1964 (Ref 1:25). Retirement costs are expected to level out at \$13.2 billion (constant 1978 dollars) by the year 2000 (Ref 1:26).

Other complaints offered by opponents of the present retirement system include the following, presented in the Report of the President's Commission on Military Compensation (Ref 1:26-27):

- (1) The current system is inequitable. Compared to most public and private-sector systems, it provides significantly more generous benefits. Both military and civilian retirement plans provide for old age needs, but military retirement is much more important than civilian plans in serving two other functions: providing incentives for continuing to 20 years of service and assisting the transition of those who leave the military before they complete a full working career. The Commission questions not the legitimacy of the latter two functions, but the extent to which lifetime annuities should be used to achieve them.

Military retirement provides generous benefits relative to private-sector plans in a second respect: military retirees' pay is completely protected against inflation, an unusual and valuable feature.

Internal inequities exist as well. Those who serve a considerable number of years in defense of their country but leave the military before serving 20 years receive no military retirement benefits. Further, because retired pay is based on the final basic pay rather than the average basic pay over some number of years, the current system may provide widely varying benefits to retirees who have quite similar work experiences.

- (2) The current system inhibits effective and flexible force management. Because the current system provides benefits only after 20 years of service, managers are reluctant to separate ineffective people who are approaching retirement eligibility. After a member has served 20 years, the availability of an immediate annuity lessens the incentive to remain on active duty. As manpower requirements change in future years, manpower managers will find that the current system constrains their ability to adapt to a changing technological and strategic environment.
- (3) The current system is inefficient. The retirement plan apparently has little influence on prospective recruits or on service members in their first enlistment. This phenomenon results from the strong preference among young people for current income rather than deferred income. For such persons, up-front compensation in the form of pay or bonuses can be a much more effective incentive than retirement.

At the same time, the existing retirement plan provides a strong incentive for more senior personnel to remain on active duty, particularly those in their twelfth through nineteenth

years of service. This occurs in part because of preference for deferred income by these older people, but more importantly it occurs because those who leave before completing 20 years of service receive nothing. Desired retention of both junior and senior personnel can be achieved at much lower costs by allocating a relatively larger proportion of total compensation to current pay.

Retirement Plan Submitted by the President's Commission

Recognizing the need for resolving the military compensation and retirement issue, the President formed the Commission on Military Compensation in June 1977, charging it "to do a complete analysis of the military compensation system in our country, to see if and how it should be improved." (Ref 1:8). The following is an excerpt of the recommendations sent to the President in April 1978.

Recommendations

Old age annuities (for military members with 10 or more years of service) should begin at age 55 for 30 or more years of service, age 60 for 20 to 29 years of service, and age 62 for 10 to 19 years of service. These annuities should be similar to those provided civil servants, integrated with social security benefits, and protected from the effects of inflation. At age 65, the recommended annuities in combination with social security replace more than 80 percent of after-tax-active duty pay for a 30-year member, and more than 65 percent of after tax active-duty pay for a 20-year member.

An interest-bearing deferred compensation trust fund should be established for each member with over five years of service. The Government should contribute an amount equal to 20 percent of basic pay to this account for those in their sixth through tenth years of service, 25 percent for years 11 to 20, 15 percent for years 21 to 25, and 5 per-

cent for years 26 to 30. The accumulated account should belong as a matter of right to members completing 10 years of service. These members should be allowed to withdraw part of their fund while on active duty. When they leave active duty, money in the fund should assist in a transition to a civilian job and should, at the member's option, be paid over several years after leaving active duty. This account which will accumulate (in today's dollars) to \$8600 at 10 years and \$42,000 at 20 years for the typical enlisted person, would provide an attractive incentive for people to continue on active duty beyond 5 years of service.

Severance pay should be extended to enlisted people. Both officers and enlisted persons mandatorily separated with 5 or more years of service should receive severance pay of one-quarter of a month's basic pay for each year of service up to 10 years, and half a month's basic pay for each year of service over 10, with a maximum of 1 year's basic pay. Severance pay assists the manager in separating those who are no longer required and in tailoring the age and experience distribution of the force to one best suited for national defense requirements.

IV. The Model

This chapter covers some basic issues concerning the construction of the model used in this thesis. The first section summarizes the approach taken in developing the model. The second section covers the model design, and the third contains a list of assumptions made in constructing the model.

The Approach

As mentioned earlier, managers of the personnel system seek to meet force structure objectives by maintaining desired grade/age profiles. These profiles are a function of accessions, reenlistments, promotions, and attrition.

Attrition presents special problems to the force managers in that voluntary separations are difficult to predict and control. Consider the situation in which civilian wages are increasing faster than military wages. This occurrence is depicted as a causal loop diagram in Figure 2. As the ratio between civilian and military wages increases, voluntary separations begin to rise. A rise in attrition causes a discrepancy in the force profile. Managers (including Congress) are pressured to reduce the discrepancy, perhaps by increasing military wage (only one of the options). The plus and minus signs indicate the direction of change that is made for an increase in the preceding factor.

This causal loop typifies the information-feedback nature of the personnel system. The model in this report is designed to capture those information feedback loops which are most important in determining the structure of the DOD enlisted force. Hypotheses about the character

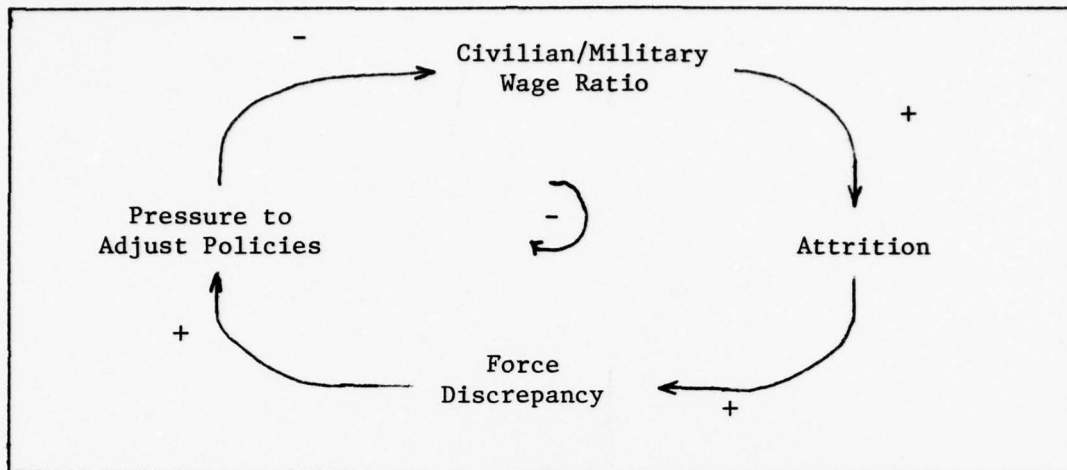


Figure 2. Pay Feedback Loop

of the feedback loops used in the model were developed from information in policy statements, regulations, and past responses to changes in the system. A combination of these feedback loops can be used to develop a flow chart for the model. Before these loops can be combined, however, a careful analysis must be made to determine the variables involved and the nature of the interaction between them. The critical loops in the personnel system involve the voluntary separation decision, the enlistment decision and the policies guiding management reaction to each of these factors.

The approach taken in model development was that enlistment could be formulated as a function of the military/civilian wage ratio and the unemployment rate. Voluntary separations are expressed as a function of pay, career expectations (promotions), and retirement benefits. As the military/civilian wage ratio decreases, voluntary separations are assumed to increase; as career expectations (as measured by deviations from TOPCAP promotion goals) decrease, voluntary separations are again

assumed to increase; and as retirement benefits decrease, voluntary separations increase.

Management Decision Making

To complete the feedback loops mentioned above, the form of the personnel managers' reactions must be determined. The decisions made by managers are controlled by policy. In developing the model, an attempt was made to capture the most general and persistent policies which are used to regulate the force profile. These policies will be covered under the headings of accessions, promotions, and attritions.

Accessions. The basic accession policy of the DOD requires that almost all personnel access through a single port of entry into the grade structure. The procurement of prior enlisted personnel to fill vacancies in certain career fields is ignored in the model.

The objective of DOD accession policy is to procure sufficient personnel to meet authorized total force levels. In stable force configurations, the accession rate is a function of the desired number of reenlistments into the career force and the continuation rate of personnel from initial enlistment to the fifth year point. Under force drawdown conditions, accession rate is a function of total force discrepancy and total force attritions and retirements. The model employs a two-year exponential average of past attritions and retirements to forecast current attrition and retirement rates. This averaging tends to emphasize current trends and to smooth out the effects of sudden peaks and valleys in these rates. When a force drawdown is in effect, managers allow the career force to deviate from the desired profile. The model is structured to accommodate accession policy under either force condition. The supply of desired accessions is assumed to be unlimited,

but the quality goals of the services may not be met. It is assumed that the DOD would like to enlist those personnel who possess at least a high school diploma. The supply of high school graduates (HSG) is not sufficient to meet this desire. While there is no direct management decision statement employed in the model to increase the number of high school graduate enlistees, the percentage of non-high school graduates procured is tracked throughout the simulation as a measure of policy effectiveness. The supply of HSG enlistments is considered to be a function of the military/civilian wage ratio and the unemployment rate. It is assumed to increase as the military/civilian ratio increases, and to decrease as the unemployment rate decreases.

Promotions. TOPCAP contains objectives for phase point and promotion opportunity to the top six grades (see Table III).

It is assumed in the model that phase point for each grade is constant. Promotion opportunity is simulated indirectly as the ratio of promotions-to-grade to equilibrium promotions-to-grade (which is assumed to reflect TOPCAP promotion opportunity goals). Any deviation from the equilibrium ratio is perceived to be a change (either plus or minus) in promotion opportunity. Accordingly, the attrition rate is assumed to change based on the direction and degree of promotion opportunity deviation. Those individuals not promoted are forced out upon reaching their grade's high year of tenure.

Attritions. DOD attrition policy covers both voluntary and involuntary attrition. Voluntary separation for cause (at times other than the first reenlistment period) are aggregated with attritions in the form of death, disability, hardship, or undesirable discharge, since they are fairly constant and can be uniformly affected by management

action. Involuntary attritions are governed by reenlistment and promotion policies. Personnel are involuntarily attrited at the reenlistment point if the number of eligibles exceeds the reenlistment requirement. All personnel not promoted are separated when they reach the high year of tenure for their specific grade.

Voluntary separation is assumed to be a function of pay, career expectations, and retirement benefits. In the model, pay adjustments (through Congressional action) are considered to be a function of attrition, so that attrition management includes a pay adjustment decision. No such decision is available under accession, promotion, and retirement policies. Furthermore, retirement benefit adjustments are exogenously input and do not respond to any variable in the model.

The Model Design

The first part of this chapter described the enlisted force personnel system as an information feedback system. This section describes the system dynamics representation of the system. The description given here has been simplified to avoid excessive use of DYNAMO terminology. A more detailed and technical description of the model design can be found in Appendix B.

Figure B-2, Appendix B, shows the flow chart from which the model was constructed. Levels are used to represent 135 grade/year categories. Each of the 9 grades is disaggregated into 15 different year-group cells. For example, grade E-4 is broken down into fifteen levels. Level 1 represents all E-4's in their first year. Level 2 represents all E-4's in their second year, and so on down to the last three year-group categories, which represent aggregate year-groups. Level 13

represents 13-20 years; level 14, 21-26 years; and level 15, 27-30 years. The last three year-group categories are aggregated to permit ease in programming. It was felt that the nature of the personnel reactions in these year-groups was similar enough to preclude erroneous interpretation of model results.

The only other levels in the system (except for the enlistment pipeline and wage indices) are the retirement pools. The retirement levels are necessary to track retirement costs. These levels are also broken down into grade/year-group categories. They were easier to program, since only two different rates (retirement rate and "death" rate) were necessary to compute the number in the level at any given time.

Except for the rates affecting the enlistment pipeline, wage indices, and retirement pools, all rates are based on the grade/year-group levels. There are only two rate equations (GAINS and LOSSES) for each enlisted category; however, each of these may consist of several categories of flows (which are defined in auxiliary equations) namely, accessions, promotions, aging, attritions, and retirements. The accession rate was covered earlier in this chapter. Each of the remaining four will be briefly explained below.

Promotion rate is computed two different ways depending on grade. Promotions to grades E-2 through E-4 is on a "fully qualified" basis. Generally, "fully qualified" status is attained by aging through the system. To simulate factors involved in cause for nonpromotion (i.e., insufficient training, poor performance) even in the lower grades, a percentage of those "eligible" to promote is held in their current grade to be promoted at a later time. Personnel in the model are eligible

for promotion to the next higher grade anytime they are in the promotion eligibility window. Promotion rate to grades E-2 through E-4 is strictly on a percentage basis once the eligibility window is reached. Promotion to grades E-5 through E-9 is according to "vacancy." As slots open up in the next higher grade, promotions are made to fill those slots. Again, the actual promotion rate is distributed through the grade by year-group with the majority being promoted who are at the TOPCAP "phase point" year (see Table III).

Attrition flows are determined as a percentage of personnel in a particular grade/year category, and are based on historical data (Ref M). Attritions will vary according to changes in military pay, perceived retirement benefits, and career expectations. The formulation of each attrition rate represents a key behavioral hypothesis. Equation (4-1) shows the form of the attrition auxiliary equation for the level grade E-4, year-group 3 (MEN.K (4,3)).

$$A \quad ATT.K(4,3) = MAX(MEN.K(4,3) * ATTMP.K(4) * ATTM.K(4,3) * ATTP.K(4) * ATTRB.K(3) * .25 * ATTN.K(4,3), 0) \quad (4-1)$$

ATT -- ATTRITION FROM EACH GRADE/AGE CATEGORY
 MEN -- PERSONNEL IN EACH GRADE/AGE CATEGORY
 ATTMP -- ATTRITION MULTIPLIER - MILITARY PAY
 ATTRB -- ATTRITION MULTIPLIER - RETIREMENT BENEFITS
 ATTN -- NORMAL ATTRITION FACTOR
 ATTM -- ATTRITION MULTIPLIER - MANAGEMENT POLICY
 ATTP -- ATTRITION MULTIPLIER - PROMOTION OPPORTUNITY

FTATTP,K(4) represents the normal first term attrition percentage for grade E-4. ATTMP, ATTP, and ATTRB are multipliers for military pay, promotion opportunity, and retirement benefits. The multipliers are computed from relationships similar to the one shown in Figure 3. The shape and slope of the curve constitute a specific hypothesis about personnel reactions to changes in military pay. ATTM in equation (4-1)

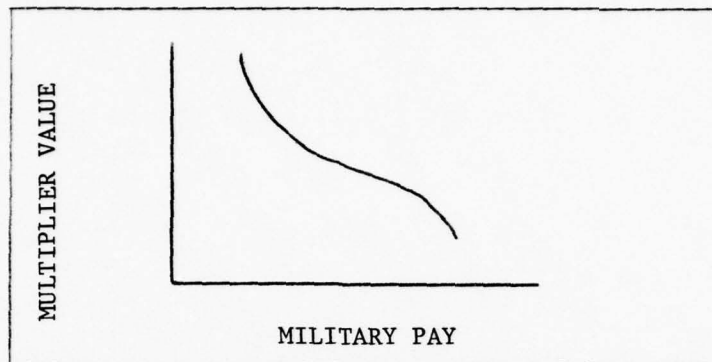


Figure 3. Multiplier for Military Pay

is an attrition management multiplier and can be used to induce changes in attrition rates in the lower three grades under specific circumstances (i.e., force buildups and drawdowns).

The retirement rate is calculated as a fixed percentage of the personnel in the retirement eligible grade/year-group categories. A management multiplier was placed into the retirement rate equation to simulate forced retirements in the event that the discrepancy in the number of personnel in the career force exceeds a designated critical value.

Under the present system, personnel who separate from the 14th and 15th year-groups are considered retirees. Under the President's Commission plan, personnel separating from the 11th through 15th year-group categories are considered retirees.

The number of personnel aging into a year-group is determined as those remaining after attritions, retirements, and promotions have been accounted for. This number is divided by the amount of time spent in the year-group category to yield an average aging rate.

The above mentioned levels and rates established the basic structure of the model. Of course, a considerable amount of effort was required to completely design and specify the system. This is described in Appendices A through F. Appendix A is a discussion of the Systems Dynamics Methodology. Appendix B contains a detailed analysis of the structure of the DYNAMO equations. Appendix C explains the methods used to monitor and accumulate the costs generated by the personnel system. Appendix D explains the initialization of the model to an equilibrium condition as well as validation and sensitivity analysis. Appendix E contains the output and analysis from a number of runs investigating the behavior of the enlisted personnel system under the policies recommended by the President's Commission. A complete program listing is provided in Appendix F.

Using the Model

In order to correctly interpret the output of the model, it is important to clearly understand the assumptions and simplifications incorporated in the model. The major assumptions and restrictions employed in the model are listed below:

- The force profile initialized into the model represents the USAF TOPCAP force structure. The entire DOD enlisted force is assumed to fit this profile.
- Stable economic conditions are assumed for the time period under study. To simplify pay calculations, civilian wages are assumed to rise in concert with the consumer price index, which is assumed to increase at a constant five percent annual rate.
- Enlistments are for only four-year increments. The only explicit

reenlistment decision occurs at the five-year point.

- The career force is defined to consist of all personnel in the fifth year-group or above.
- Some discrete events are treated as continuous. For example, personnel are continually selected for promotion in the model. In actuality, the selection process is at most a biannual occurrence (although "pin-on" dates occur continuously as vacancies open).
- The basic unit of time in the model is one-quarter of a year.

Other assumptions and simplifications are cited throughout the report.

It is important to realize that this model can be used to compare alternative retirement and compensation scenarios, not predict specific cost estimates. Any use of this model should be based on this knowledge.

V. Analysis of the President's Commission Proposal

Analysis of the effects of the compensation policies presented by the President's Commission is intended to examine both the cost trends and enlisted force profile implications resulting from hypothesized reactions of DOD enlisted personnel to changes in the military compensation system. Since the enlisted force is only a portion of total DOD personnel, broad statements about the impacts on total DOD costs are not presented. Inclusion of the cost implications on the officer force would give a more complete understanding of the total cost impacts of changing retirement policies.

The President's Commission compensation system was developed to reduce cash outlays for retirement. This reduction in cost is expected to occur by lowering overall benefits offered and inducing a particular pattern in enlisted retention (attrition) rates. While this change in retention pattern is likely to reduce retirement costs, it is not clear that total DOD costs for the enlisted force will also decrease.

In order to examine major cost trends, an enlisted force size of 1,838,500 was used in the model. The force, assumed to be in perfect balance under TOPCAP objectives, is aged over a twenty-year span. The only disturbances to the equilibrium force are in the form of hypothesized behavioral responses after implementation of the Commission retirement plan. Any change in the force profile can be easily detected. Because of the structure of the model, changes can be traced to specific policies. Basic cost trends should remain valid under a range of force profiles. While the size of the force used in the model closely approximates the size of the current enlisted force, the temptation to make

point cost estimates should be avoided. The results covered in the analysis are oriented towards relative comparisons of size and direction of change in the components of total system costs.

Costing

Four cost categories will be reported in each simulation run under the various behavioral hypotheses:

- (1) Accession costs, to include recruiting and initial training costs
- (2) Total active duty pay
- (3) Separation travel pay
- (4) Total retirement pay, to include (when appropriate) separation pay and total costs incurred for the deferred compensation trust fund.

The cost of the equilibrium retired force is initialized into the model. Therefore, the retirement cost presented includes the cost of the current retired force. The sum of the four costs will be used as an indicator of total relevant system costs. Tradeoffs between the four cost categories will occur as attrition rates change. Accession cost, for example, is directly proportional to total force attrition, as is separation travel cost and active duty pay (under the assumption that military pay is responsive to force attrition). Also, total retirement pay will fluctuate as the force profile changes. Furthermore, as the force profile changes, career progression (promotions) will change and in turn affect attrition rates.

Costs are formulated with the President's Commission retirement plan under full implementation. There is no transition between the present retirement system and the Commission proposal. The cost implications of this transition period are substantial but are not a part of this

preliminary analysis.

The reduction in retirement benefits at age 65 due to Social Security contributions attributable to military service is not accounted for in the model. A constant inflation rate of 5 percent is used for future costing, and present values are computed by continuous discounting at 7 percent for active duty costs and 2 percent for retirement costs (since in the model active duty costs were adjusted for the 5 percent annual inflation while retirement pay was kept in constant 1978 dollars).

Behavioral Hypotheses

A vital part of the analysis lies in the formulation of hypotheses concerning personnel reaction to the new retirement proposal (or one similar to it) presented by the Commission. According to the Commission, the new retirement plan will produce three major trends in attrition patterns:

- (1) decrease attrition in year-groups 5 to 12
- (2) increase attrition in year-groups 13 to 20
- (3) decrease attrition in year-groups 21 to 30.

This set of reactions will be hereafter referred to as the "intended system response."

The proposed annuity and deferred compensation trust fund for those personnel completing at least ten years of service provide strong support for the hypothesis of decrease in attrition rates for year-groups 5 to 12. Under the current system, no payment is made to personnel leaving the military with less than 20 years of service.

The same features of the proposal also support the second hypothesis. Whereas under the current system, personnel are obligated to remain in

the service for 20 years in order to receive retirement pay, an opportunity exists under the Commission proposal to leave any time after 10 years and still receive compensation benefits. The Commission also reasoned that a constant increase in old-age annuity benefits would provide incentive for those in the 21 to 30 year-groups to remain on active duty.

Structure of the Analysis

As a base for comparing hypotheses, the model was first run under both retirement systems without any changes in attrition rates. Simulations after this run involved some degree of personnel reaction to the President's Commission retirement plan.

The hypothesis of intended system response is investigated on three levels of intensity. The parameter values selected to represent these intensities are chosen to show cost and profile trends, not to predict actual personnel response. The model inputs used to achieve these responses are summarized below:

Low Intended System Response

- Attrition in year-groups 5 to 12 decreased 5%
- Attrition in year-groups 13 to 20 increased 10%
- Retirements in year-groups 21 to 30 decreased 5%

Moderate Intended System Response

- Attrition in year-groups 5 to 12 decreased 20%
- Attrition in year-groups 13 to 20 increased 20%
- Retirements in year-groups 21 to 30 decreased 10%

High Intended System Response

- Attrition in year-groups 5 to 12 decreased 30%
- Attrition in year-groups 13 to 20 increased 30%
- Retirements in year-groups 21 to 30 decreased 10%

Each of the three response patterns is investigated under normal model conditions. Results are presented in the form of cost trends as compared to the present system equilibrium costs. An increase (+) or decrease (-) from the base run is indicated for each response (see Table V).

Results

Table V indicates that the Commission proposal results in a substantial decrease in both retirement pay and total system cost. Even though the number of personnel eligible for retirement annuities (at any specific time) increases by a factor of five, the proposed compensation package does not approach the obligations incurred by the current retirement system. Total active duty pay decreases very slightly in the last two responses. This is due to a net decrease in active duty pay in the first term force. Accession costs also increase slightly as the intended system response increases. While the increase in accessions was predicted in the Commission report (Ref 1:88), the degree of predicted increase is higher than indicated in this analysis. Furthermore, the expected changes in the force profile (increase of personnel in the 5 to 12 year-groups and decrease of personnel in the 13 to 20 year-groups) were reversed due primarily to the promotion and attrition policies incorporated in the model.

TABLE V
Estimated Cost Implications of the President's
Commission Compensation Proposal

Cumulative Costs in Billions						
Case	Accession Costs	Active Duty Pay	Sep. Travel Pay	Total Retire- ment Pay	Total System Cost	Discounted Total System Cost
Present System	101.3	678.8	7.9	131.8	919.8	492.8
PC, No Response	NC	NC	NC	-66.1	-66.1	-54.6
PC, Low Intended Response	+1.1	+1.2	NC	-66.2	-66.0	-54.5
PC, Moderate Intended Response	+1.3	-.3	NC	-65.7	-64.7	-53.8
PC, High Intended Response	+1.9	-.6	+1.1	-64.7	-63.3	-52.7

NOTE: 1. PC signifies President's Commission
2. Minus (-) reflects lower cost. Plus (+) reflects higher cost. NC reflects no change in cost.

Conclusions

Reliance on the results contained in this report is based on confidence in the model as a reasonable representation of the DOD enlisted personnel system. At the least, it is hoped that the model can be useful in further examination of behavior in the enlisted force. It is expected that a better understanding of the numerous policies affecting the personnel system will render the model an even greater tool. The results

obtained in this analysis must be interpreted in the context of all model assumptions. While this analysis demonstrated an overwhelming cost savings under the President's Commission proposal, differing model assumptions may render varying magnitudes of individual and total system costs. It seems apparent, however, that the implementation of the Commission proposal would substantially cut DOD costs in the enlisted force. Only a severe rejection of the Commission plan by enlisted personnel would prohibit cost savings under the new system.

BIBLIOGRAPHY

1. Report of the President's Commission on Military Compensation. Washington D.C.: U.S. Government Printing Office, 1978.
2. Carpenter, M. F. and M. R. Lacey. A Preliminary System Dynamics Investigation of Alternative Military Retirement Programs. AFIT Thesis, AFIT/GOR/SM/77D-3, 1977.
3. Communication From the Office of the Assistant Secretary of Defense, Manpower and Reserve Affairs. Pentagon, Washington D.C.
4. Martin, A. J. "Trends in DOD First-Term Attrition," Volume I: Papers From Proceedings of Conference held at Leesburg, Virginia, April 4, 1977.
5. The USAF Personnel Plan: Volume III Airman Structure Annexes. Washington D.C., Department of the Air Force, September 1975.
6. The USAF Personnel Plan: Volume III. Washington D.C.: Department of the Air Force, September 1975.
7. Pugh, Alexander L. III, DYNAMO User's Manual (5th Edition). Cambridge, Massachusetts: MIT Press, 1977.
8. Air Force Regulation 173-10. Washington D.C.: Department of the Air Force, January 1977.
9. Cooper, Richard V. L. Military Manpower and the All-Volunteer Force. RAND, R-1450-ARPA, September 1977.
10. Goodman, M. R. Study Notes in System Dynamics. Cambridge, Massachusetts: Wright-Allen Press, 1974.
11. Recruiting For the All-Volunteer Force, A Summary of Costs and Achievements. Washington D. C.: U.S. General Accounting Office, October 1977.
12. Forrester, J. W. Principle of Systems. Cambridge, Massachusetts: MIT Press, 1973.
13. Anderson, D. F. and Emmericks, R. M. Preliminary Thoughts On the Development of a Behavioral Analysis Model of the Military Personnel System. Unpublished Paper, January 1975.
14. Knight, J. M., Pope, W. H., and Polk, S. B. Integrated Simulation Evaluation Model (ISEM) of the Air Force Manpower and Personnel System: Requirements and Concepts. AFHRL-TR-77-63. San Antonio, Texas: Air Force Human Resources Laboratory, August 1977.

15. DeVany, A. S., Saving, T. R., and Shugart, W. J. II. Supply Rate and Equilibrium Inventory of Air Force Enlisted Personnel: A Simultaneous Model of the Accession and Retention Markets Incorporating Force Level Constraints. AFHRL-TR-77-63. San Antonio, Texas: Air Force Human Resources Laboratory, 1978.
16. Cooper, Richard V. L. The All-Volunteer Force: Five Years Later. RAND Report, R-6051. December, 1977.
17. Fiscal Year 1977. Military Personnel Policy Report on Enlisted Management Prepared By Defense Management Data Center, Monterey, California.

APPENDIX A

The System Dynamics Methodology

APPENDIX A

The System Dynamics Methodology

The following explanation of the system dynamics methodology is extracted from the Carpenter/Lacey report (Ref 2:28-32). Some of the levels and rates are redefined to harmonize with those used in this model.

System Dynamics refers to a modeling methodology developed by J. W. Forrester of Massachusetts Institute of Technology (M.I.T.) and based on information-feedback control theory. According to Forrester, "The general concepts of information-feedback systems are essential because such systems exhibit behavior as a whole which is not evident from examination of the parts separately. The pattern of system interconnection, the amplification caused by decisions and policy, the delays in actions, and the distortion in information flows combine to determine stability and growth." The basic structure of a System Dynamics model consist of a number of "levels" and "flows" such as shown in Figure A-1. The levels represent accumulations with the system (for example, the number of master sergeants (E-7's) or the number of retirees at a given time); the flows are used to provide the inputs and outputs for the levels (for example, promotions into the master sergeant level or attritions out of the master sergeant level). The flows are controlled by decision functions which depend only on information about the levels.

The value of a level is computed by integrating (over time) the net flow rate. In equation form:

$$L \quad \text{LEVEL.K} = \text{LEVEL.J} + (\text{DT}) * (\text{IN.JK} - \text{OUT.JK}) \quad (\text{A-1})$$

The L to the left of the equation indicates that this equation defines a level. The value of the level at time K is equal to its value in the previous time period (J) plus the difference between the flow in (IN.JK) and the flow out (OUT.JK) during the time increment (DT). The time script K is used to represent the current time; J indicates the previous time (i.e., K minus DT); and L is used to indicate the next time (K plus DT). Flows have double time scripts to indicate that they remain constant over the time increment used for integration. This approximates the integrating of a continuous function when DT is small. The flow equations are designated with an R (for rate):

$$R \quad \text{OUT.KL} = \text{LEVEL.K} / \text{DELAY} \quad (\text{A-2})$$

Equation (A-2) indicates that the flow OUT which will exist over the next time increment is equal to the current value of the level divided by a constant (labeled DELAY). For example, OUT might represent the annual attrition rate of master sergeants. If one percent of all master sergeants attrited each year then DELAY would be set equal to 100. The flow OUT would then remove one percent of the level of master sergeants each year. Figure A-2 shows the flow OUT and the information used to determine it. The rate equations are used to create the decisions in the system. Some of the decisions are "implicit," such as in Equation (A-2), in that they are unavoidable results. "Overt" decisions, however, can be formulated in the rate equations to simulate management or personnel decisions. A closed loop feedback system can be represented by alternating level and rate equations. Future rates are determined by information about present levels and then used to

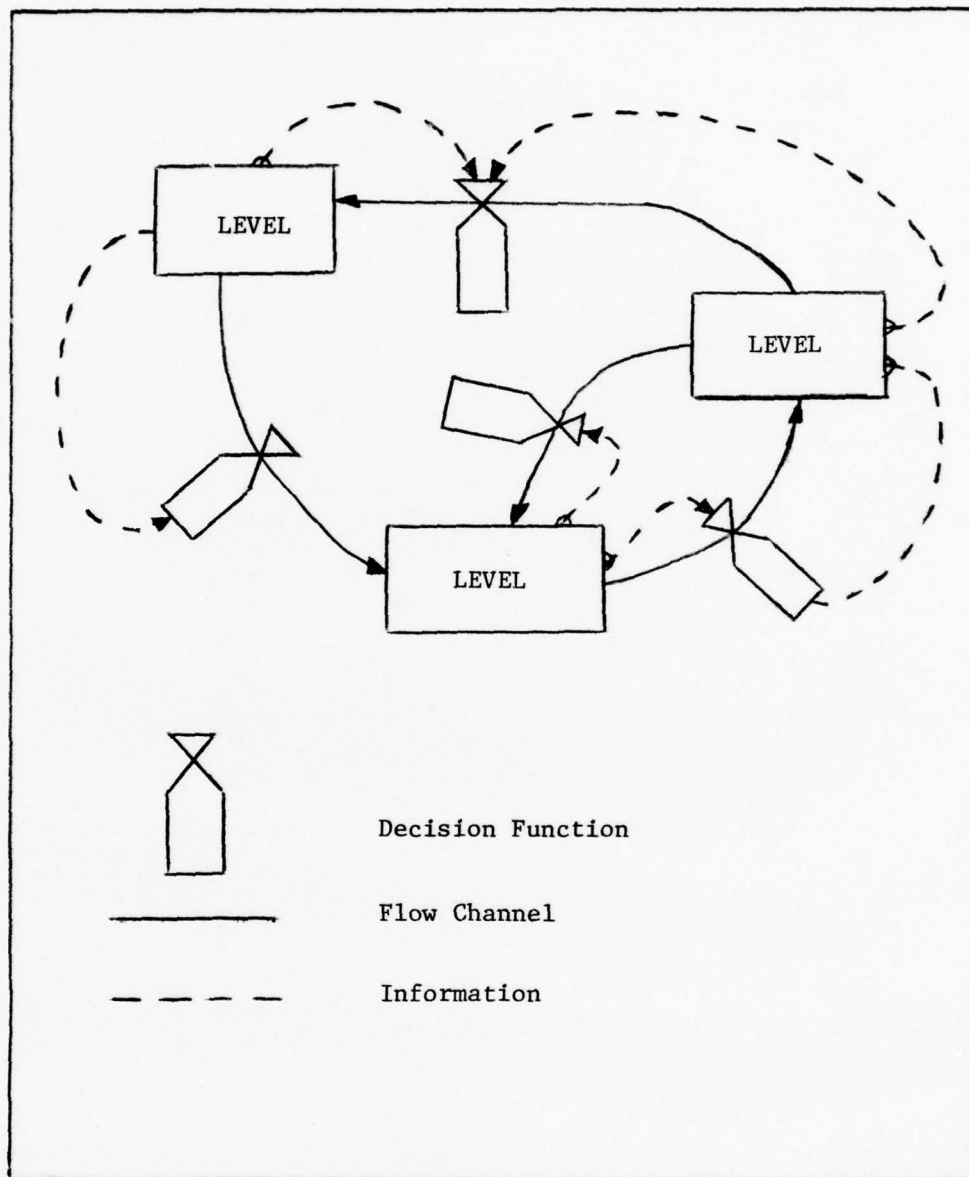


Figure A-1. System Dynamics Model

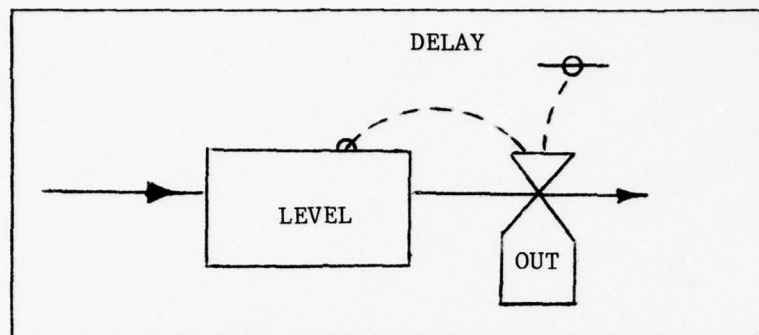


Figure A-2. Rate Equation

to determine the future value of the levels.

To provide ease in programming, several other types of equations are used in building a model. Auxiliary equations (designated by an A) can be used as intermediate equations to keep the level and rate equations from becoming unwieldy. Constant (C), initial condition (N), and table (T) equations are used for inputting parameters and data. The programming language is called DYNAMO; additional information on it can be obtained from the DYNAMO User's Manual (Ref 7).

APPENDIX B

Model Documentation

APPENDIX B

Model Documentation*

General Description of the Model

The model used in this analysis consists of three major parts: A structural representation of the DOD Enlisted Force Personnel System (EFPS), a module which monitors and accounts for costs for evaluative purposes and a model of the retired enlisted force, which represents the distribution of retired personnel.

This appendix presents the structural model. The cost module and the retired force representation will be presented in Appendix C.

The major emphasis during building the model was to represent the EFPS in a continuous and aggregate fashion with emphasis on how and why personnel enter, progress through, and leave the system. The model considers all the enlisted grades E-1 through E-9.

An outstanding characteristic of the EFPS that lends itself to simulation modeling is that it is basically a closed internal labor market. Personnel are accessed at a definite port of entry (as an E-1 enlistee); requirements for all other grades above E-1 can be supplied only from the grade immediately below it. Two exceptions are when (1) prior service personnel are procured and (2) reserve members enter the system in wartime circumstances. Lateral entry is not considered in the model. Faced with the closed nature of the system, personnel planners must place emphasis on long-range planning with primary

*This appendix presupposes a familiarity with the system dynamics methodology and the DYNAMO simulation language.

objectives of (1) maintaining the enlisted force near the level authorized by Congress and (2) maintaining a balanced grade structure as prescribed by Congress. Consider for example, a change in the attrition rate in the enlisted force. Attrition may be determined by several factors beyond the control of personnel management, including military pay and retirements. However, to meet the short term objectives, a change would be made in career progressions. In order to meet force level objectives, more people would have to be promoted, and more accessions would be required to compensate for the higher turnover rate. The higher promotion rate may have the affect of slowing attrition from the force, thereby bringing attritions back down to "desired" levels. Add to this chain of interactions the delay of personnel perceiving changes in the system and you have a system which is impossible to analyze by intuition alone. The model, then, is an attempt to capture most of the important interactions of the EFPS in order to better understand the dynamic behavior of the system. The following is a general discussion of the major features of the model; a detailed description follows later in this appendix.

Model Aggregation. All models require some degree of aggregation. The extent of the aggregation is dependent on the purpose of the model. This model attempts to simulate movement into, through, and out of the DOD enlisted force, with the objectives being (1) to analyze the effects of personnel policy application on the force and (2) to analyze the effects of different behavior responses to changes in the personnel system. Given the purpose and objectives of the model, the level of aggregation chosen was by enlisted grade and year of service.

The aggregation was accomplished by constructing an array out of

the force (illustrated in Figure B-1). One element of the array is grade and the other year of service. Each grade E-1 through E-9 is a separate category. Year-groups 1 through 12 each have their own category, while categories 13 through 15 comprise a number of year-groups together (see Figure B-1). The aggregation of the last 18 years into 3 categories was based on homogeneity of behavior in these groups.

Personnel Management Policy Incorporated in the Model. Management policy included in the model is based on policy set forth in the USAF Personnel Plan for the enlisted force (TOPCAP).

Accessions are created based on predicted attritions, retirements, and career force discrepancy. Promotions are made into the top five grades to maintain the authorized percentage of the total force in each of these grades. Promotions to E-2 through E-4 are modeled by using average time in grade to promotion.

Attritions are handled as a percentage of the force levels and management policy can either slow down or speed up first term attrition by way of increasing or decreasing early outs. Retirements are handled similarly as a percentage of the level with management policy allowing an increase or decrease in times of large rapid drawdowns or buildups.

Initialization and Interpretation. The force examined in this model is hypothetical. The model is started at equilibrium such that all levels are constant. This means there is a constant enlistment rate feeding the system and all management goals are met. Such a system is at an optimum and will remain in that state until disturbed. Obviously the enlisted personnel system has never been in this condition and never will be. However, it is important to start the system in equilib-

Figure B-1. Grade/Year Category Array

Figure B-1. Grade/Year Category Array

rium, so that when the system is disturbed, you can observe the response of the system to that particular disturbance. These same responses would be present in a system not in equilibrium but the system response to a particular disturbance may be observed by the normal oscillations in the system. From an equilibrium start, however, you are better able to detect problem areas in the system and make better adjustments to management policy.

Detailed Model Description

This section will present a detailed look at equation formulation using DYNAMO, version III F. In each of the equations discussed, assumptions behind its formulation will be revealed. Since the model is somewhat repetitive in structure, only representative equations will be explicitly covered. Level equations will be covered first followed by the rate equations. The six major sections (accessions, recruiting, promotion flows, attrition flows, retirement flows, and aging flows) will then be discussed separately.

Level Equations. All of the level equations are constructed in the standard DYNAMO format and can be formulated by referring to Figure B-2. The content of any level at the present time, K, is simply the content of the level at the previous time period, J, plus the net flow in or out (gains and losses) of the level for the DT period between J and K.

$$\begin{array}{ll}
 \text{L} & \text{MEN.K(GD, YR)} = \text{MEN.J(GD, YR)} + \text{DT} * (\text{GAINS.JK(GD, YR)} \\
 \text{X} & \quad - \text{LOSSES.JK(GD, YR)})
 \end{array}
 \tag{B-1}$$

MEN -- PERSONNEL IN EACH GRADE/AGE CATEGORY
 GAINS -- RATES AT WHICH PERSONNEL ENTER
 EACH GRADE/YEAR CATEGORY
 LOSSES -- RATES AT WHICH PERSONNEL LEAVE
 EACH GRADE/YEAR CATEGORY

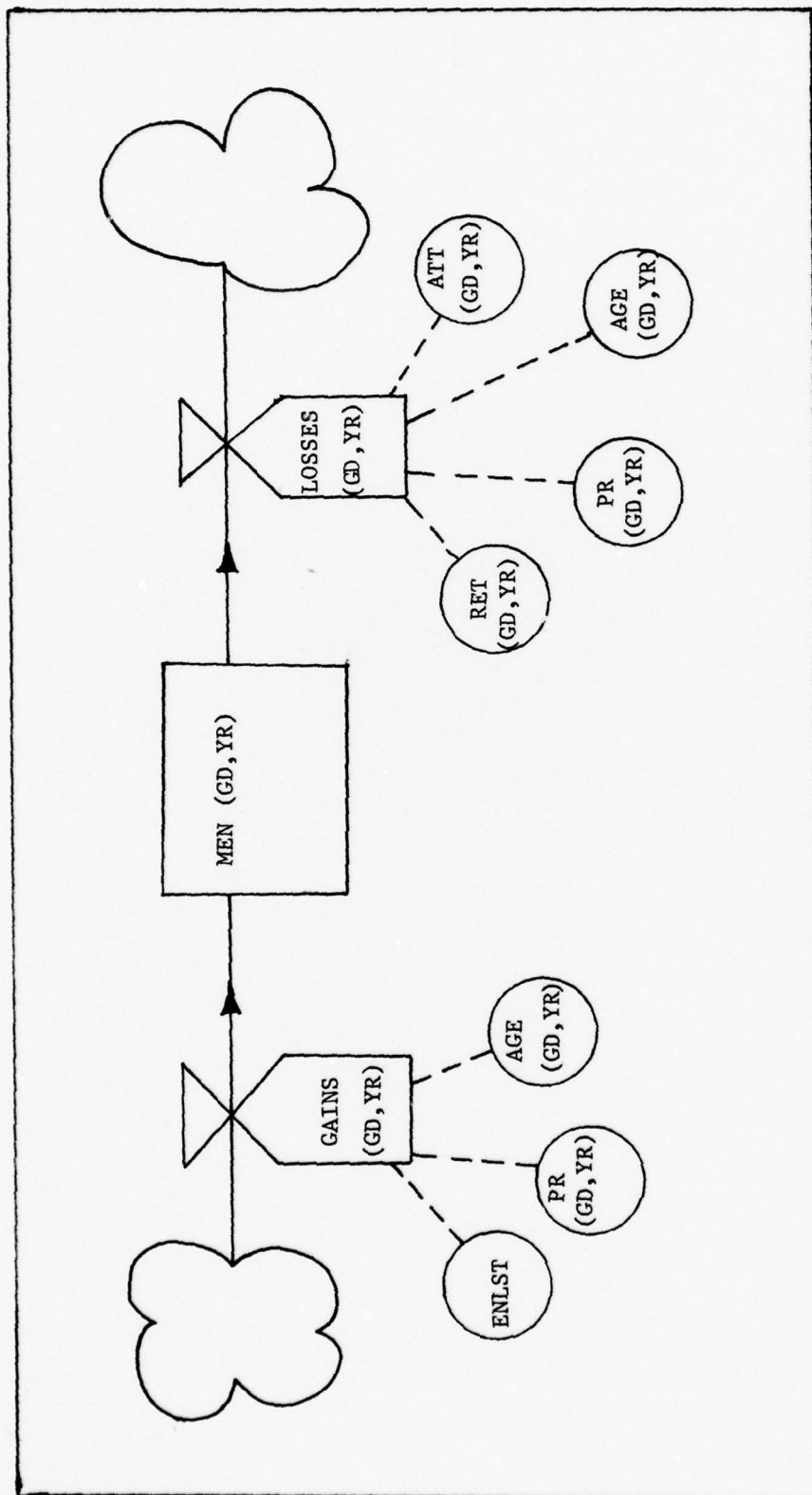


Figure B-2
Model Flow Chart

Retirement levels are formulated to facilitate costing. The formulations of these levels are not critical to the force structure portion of the model and are discussed in Appendix C.

Rate Equations. There are two types of rates in the model, gains and losses. These rates are comprised of a combination of flows. These flows are accessions (enlistments), promotions, retirement, attritions, and aging (dashed lines in Figure B-2). Gains can include promotions into a category, enlistments (only into category 1,1), and aging into a category. Losses can be by promotion, retirement, attrition, or aging. The rates (gains and losses) are represented as arrays, with a gain and loss rate for each grade-year category (Figures B-3 and B-4). For descriptive purposes, the arrays in Figures B-3 and B-4 have been divided into blocks of grade-year groups. The significance of these blocks is that all of the grade-year groups in the same block have gains (or losses) that are made up of the same flows.

Gain Rates. The gain rate equations corresponding to the blocks in Figure B-3 are presented and explained below.

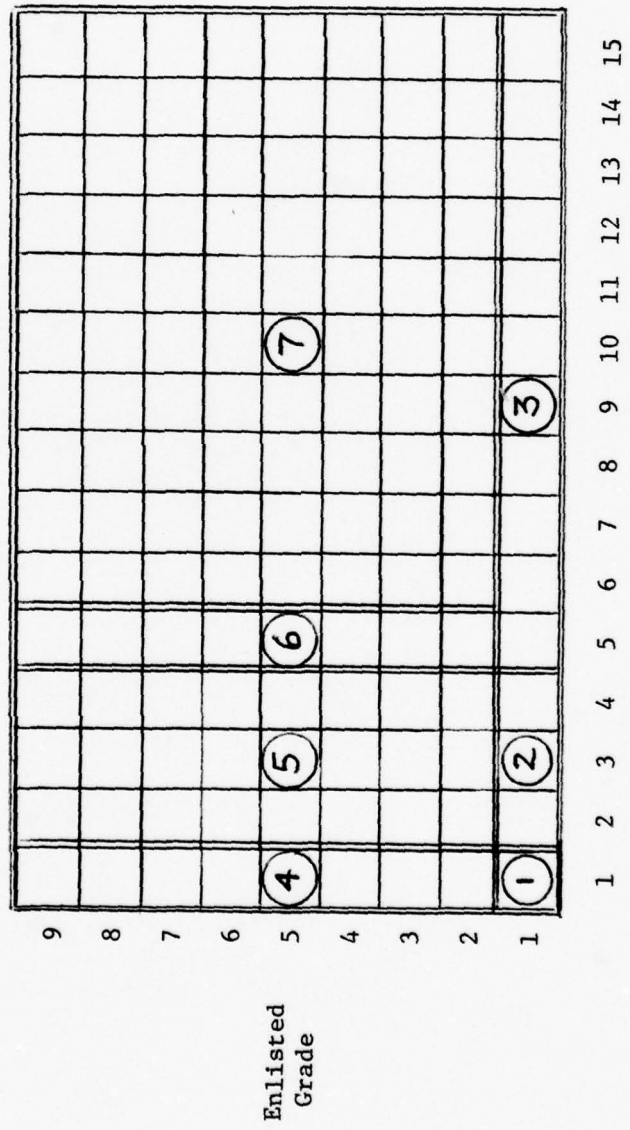
$$R \quad \text{GAINS.KL}(1,1) = \text{ENLST.K} \quad (B-2)$$

ENLST -- ENLISTMENTS INTO THE FORCE

Gains into grade E-1, year-group 1 can only be by enlistment. This is one of the basic assumptions of the model; that all enlistments are into grade E-1 and year-group 1.

$$\begin{aligned} R \quad \text{GAINS.KL}(1, \text{YRC}) &= 0 \\ R \quad \text{GAINS.KL}(1, \text{FDU}) &= \text{AGE.K}(1, \text{FDU}) \end{aligned} \quad (B-3)$$

AGE -- RATE OF AGEING INTO EACH GRADE/YEAR CATEGORY



Years of Service

Figure B-3 Gains Array

These equations reflect that E-1's are allowed to stay in the service only through the fourth year (YRC = 5 to 15) and that the only way to enter another E-1 category (FDU = 2 to 4) is by aging.

$$R \quad \text{GAINS.KL(GDU, 1)} = \text{PR.K(GDU, 1)} \quad (\text{B-4})$$

PR -- PROMOTIONS INTO EACH GRADE/YEAR CATEGORY

Gains into the first year group for all grades except the first (GDU = 2 to 9) is possible only through promotion into the category.

$$R \quad \text{GAINS.KL(GDU, SDU)} = \text{PR.K(GDU, SDU)} + \text{AGE.K(GDU, SDU)} \quad (\text{B-5})$$

The grade/year groups in block 5 (Figure B-3) can be entered by either being promoted or by aging into the category.

$$R \quad \text{GAINS.KL(GDU, 5)} = \text{MAX}(\text{REUP.K(GDU)}, 0) + \text{PR.K(GDU, 5)} \quad (\text{B-6})$$

REUP -- REENLISTMENTS BY GRADE
PR -- PROMTIONS INTO EACH GRADE/YEAR CATEGORY

This gain equation incorporates two key assumptions in the model. First, it assumes all reenlistments take place at the beginning of the fifth year of service. Second, it assumes that reenlistees are selected from those who would age into the fifth year group (the assumed reenlistment point) starting with those in the highest grade and working down until the desired number of reenlistments has been satisfied (see the REUP equations, B-28). So gains into this block of categories is

the sum of those who reenlist and those who are promoted into that category.

$$R \quad \text{GAINS.KL(GDU, FDU)} = \text{PR.K(GDU, FDU)} + \text{AGE.K(GDU, FDU)} \quad (B-7)$$

PR -- PROMOTIONS INTO EACH GRADE/YEAR CATEGORY
AGE -- RATE OF AGEING INTO EACH GRADE/YEAR CATEGORY

This equation is identical to the equation for block number 5. It covers gains into grades E-2 through E-9, year groups 6 through 15.

Loss Rates. The loss rate equations corresponding to the blocks in Figure B-3 are presented and discussed below.

$$R \quad \text{LOSSES.KL(TOP, OLD)} = \text{ATT.K(TOP, OLD)} + \text{RET.K(TOP, OLD)} \quad (B-8)$$

ATT -- ATTRITIONS FROM EACH GRADE/YEAR CATEGORY
RET -- RETIREMENTS FROM EACH GRADE/YEAR CATEGORY

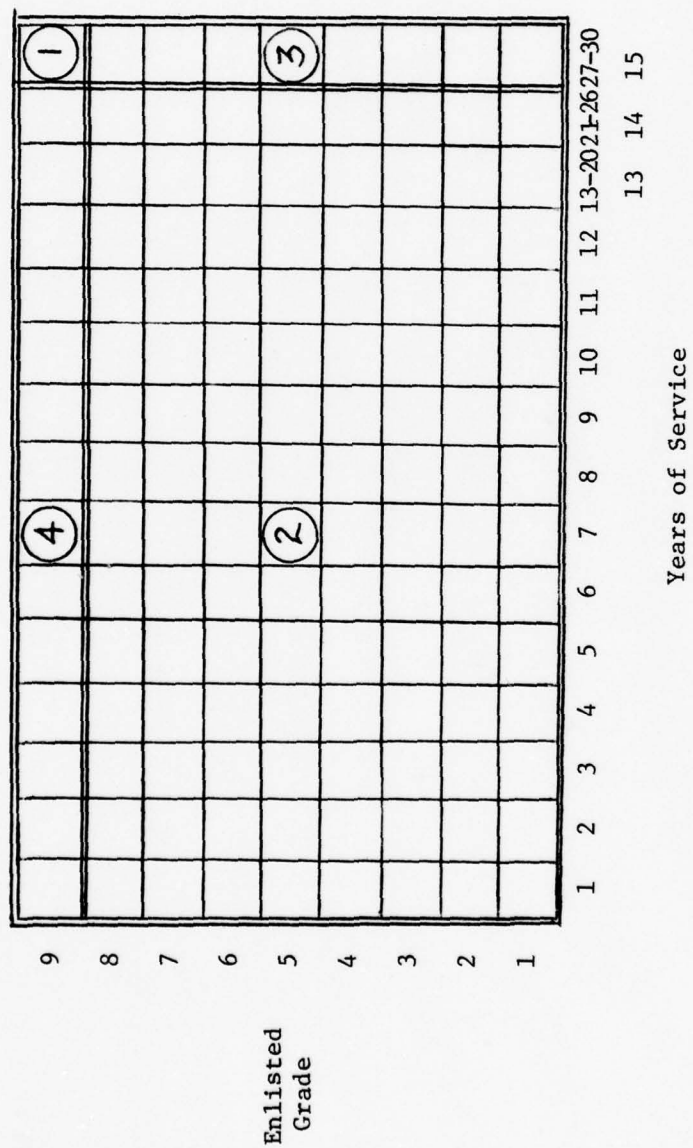
The only ways to leave the highest grade year category (TOP = 9, OLD = 15) are by retirement or attrition. In the basic model, everyone who leaves after 20 years is considered as retired. Therefore, the first component for this category will normally be zero.

$$R \quad \text{LOSSES.KL(GDL, YRL)} = \text{ATT.K(GDL, YRL)} + \text{RET.K(GDL, YRL)} \quad (B-9)$$

$$X \quad + \text{PR.K(GDL+1, YRL)} + \text{AGE(GDL, YRL+1)}$$

ATT -- ATTRITIONS FROM EACH GRADE/YEAR CATEGORY
RET -- RETIREMENTS FROM EACH GRADE/YEAR CATEGORY
PR -- PROMOTIONS INTO EACH GRADE/YEAR CATEGORY
AGE -- RATE OF AGEING INTO EACH GRADE/YEAR CATEGORY

The grade/year groups in block 2 of Figure B-4 can be exited by attrition and retirement, by promotion to the next higher grade, and by aging into the next higher year group.



$$\begin{array}{l} \text{R} \quad \text{LOSSES.KL(GDL, OLD)} = \text{ATT.K(GDL, OLD)} + \text{RET.K(GDL, OLD)} \\ \text{X} \quad + \text{PR.K(GDL+1, OLD)} \end{array} \quad (\text{B-10})$$

ATT -- ATTRITIONS FROM EACH GRADE/YEAR CATEGORY
 RET -- RETIREMENTS FROM EACH GRADE/YEAR CATEGORY
 PR -- PROMOTIONS INTO EACH GRADE/YEAR CATEGORY

Losses from grade E-1 to E-8 (GDL) in the year-group category 15 (OLD), consist of attritions, retirements, and promotions to the next higher grade. The retirement rates are set up so that everyone in a year-group (27 to 30 years of service) is retired after four years in this category.

$$\begin{array}{l} \text{R} \quad \text{LOSSES.KL(TOP, YRL)} = \text{ATT.K(TOP, YRL)} + \text{RET.K(TOP, YRL)} \\ \text{X} \quad + \text{AGE.K(TOP, YRL+1)} \end{array} \quad (\text{B-11})$$

LOSSES -- RATES AT WHICH PERSONNEL LEAVE EACH GRADE/AGE CATEGORY
 ATT -- ATTRITION FROM EACH GRADE/AGE CATEGORY
 RET -- RETIREMENTS FROM EACH GRADE/AGE CATEGORY
 PR -- PROMOTIONS INTO GRADE/AGE CATEGORY
 AGE -- RATE OF AGEING INTO EACH GRADE/AGE CATEGORY

Losses from any E-9 category (TOP) in year-groups 1 to 14 (YRL) can occur only as attritions, retirements, or by aging into the next year-group. Individuals cannot be promoted out of an E-9 category.

Force Structure Equations. Before discussing the major sections of the model, it is useful to present some general force structure equations and clarify some terms used throughout the remainder of this Appendix.

The model has been given an initial size which is defined as the authorized enlisted force. The authorized career force is defined as a fixed percentage of the total force. The variables TEST 1 and TEST 7 are used to simulate, respectively, changes in force authorizations

A $FORCE.K = 1838500 + TEST1.K$
 FORCE -- PERSONNEL AUTHORIZED IN THE ENLISTED FORCE
 MENI -- INITIAL FORCE PROFILE
 TEST1 -- TEST ON TOTAL FORCE AUTHORIZATIONS (B-12)

A $ACARF.K = FM.K * FORCE.K$
 ACARF -- AUTHORIZED CAREER FORCE
 FORCE -- PERSONNEL AUTHORIZED IN THE ENLISTED FORCE
 FM -- FORCE MIX (CAREER PERCENTAGE)

A $FM.K = FMC + TEST7.K$
 FM -- FORCE MIX (CAREER PERCENTAGE)
 TEST7 -- TEST ON FORCE MIX

C $FMC = .41259$
 FMC -- FORCE MIX CONSTANT
 YPROFI -- INITIAL YEAR PROFILES
 FORCE -- PERSONNEL AUTHORIZED IN THE ENLISTED FORCE

A $TEST7.K = RAMP(TFMC/FMAT, FMST) + RAMP(-TFMC/FMAT, FMST + FMAT)$
 TEST7 -- TEST ON FORCE MIX
 TFMC -- TOTAL FORCE MIX CHANGE PERCENTAGE
 FMAT -- FORCE MIX ADJUSTMENT TIME
 FMST -- START TIME FOR FORCE MIX CHANGE

(force drawdowns and buildups) and changes in the desired force mix.

Other variables and their equations that are used often are presented below without comment.

A $CARF.K(GD) = SUMV(MEN.K(GD, *), 5, OLD)$
 CARF -- ACTUAL CAREER FORCE BY GRADE
 MEN -- PERSONNEL IN EACH GRADE/AGE CATEGORY

A $TCARF.K = SUM(CARF.K)$
 TCARF -- TOTAL ACTUAL CAREER FORCE
 CARF -- ACTUAL CAREER FORCE (B-13)

A $CATT.K(GD) = SUMV(ATT.K(GD, *), 5, OLD)$
 CATT -- CAREER ATTRITIONS BY GRADE
 ATT -- ATTRITION FROM EACH GRADE/AGE CATEGORY

A $TCAT.K = SUM(CATT.K)$
 TCAT -- TOTAL CAREER ATTRITIONS
 CATT -- CAREER ATTRITIONS BY GRADE

A $CRET.K(GD) = SUMV(RET.K(GD, *), 5, OLD)$
 CRET -- CAREER RETIREMENTS BY GRADE
 RET -- RETIREMENTS FROM EACH GRADE/AGE CATEGORY

A $TCRET.K = SUM(CRET.K)$
 TCRET -- TOTAL CAREER RETIREMENTS
 CRET -- CAREER RETIREMENTS BY GRADE

```

A   GPROF.K(GD)=SUMV(MEN.K(GD,*),1,OLD)
      GPROF  -- GRADE PROFILE
A   YPROF.K(YR)=SUMV(MEN.K(*,YR),1, TOP)
      YPROF  -- YEAR PROFILE
A   TRET.K=SUM(RET.K)
      TRET   -- TOTAL RETIREMENTS
A   TATT.K=SUM(ATT.K)
      TATT   -- TOTAL ATTRITIONS
A   TPR.K=SUM(PR.K)
      TPR    -- TOTAL PROMOTIONS
A   TOTF.K=SUM(MEN.K)
      TOTF   -- TOTAL FORCE SIZE
A   P.K(1)=0
A   P.K(GDU)=SUMV(PR.K(GDU,*),1,OLD)
      P      -- PROMOTIONS BY GRADE

```

Accession Flow and Reenlistment. Enlistments and reenlistments are closely related in the model and will be discussed together. Two policies guide DOD force managers in determining accession rates. The particular policy (and the corresponding accession equation) depends on the size of the force adjustment. Under normal conditions, force managers act to maintain the desired career force profile as well as total force size. However, during periods of force drawdowns, force managers allow the career force to fluctuate while giving priority to meeting year end strength goals. To determine the demand for accessions under the differing management policies, two distinct equations are formulated. The equations are structurally similar but differ enough to warrant separate discussion.

For normal adjustments to the force, enlistments will be made to compensate for forecasted attritions and retirements, and to correct the career force discrepancy. First, the desired number of reenlistments is computed.

In order to meet career force objectives (REEN), enough people will have to be accessed (DNORM), to compensate for first-term attrition.

A REEN.K=MAX(CFDSC.K/CFADT+SMOOTH(TCAT.K,AST)
 X +SMOOTH(TCRET.K,AST),0) (B-14)

REEN -- DESIRED GAINS INTO YEAR GROUP 5
 CFDSC -- CAREER FORCE DISCREPANCY
 TCAT -- TOTAL CAREER ATTRITIONS
 AST -- ATTRITION SMOOTH TIME
 TCRET -- TOTAL CAREER RETIREMENTS

A CFDSC.K=ACARF.K-TCARF.K (B-15)

CFDSC -- CAREER FORCE DISCREPANCY
 ACARF -- AUTHORIZED CAREER FORCE
 TCARF -- TOTAL ACTUAL CAREER FORCE

This is accomplished by dividing desired reenlistments by a computed continuation rate:

A CONR.K=SUMV(AGE.K(*,5),1,TOP)/SMOOTH(EFYA.K,4) (B-16)

CONR -- FIRST TERM CONTINUATION RATE
 AGE -- RATE OF AGING INTO EACH GRADE/AGE CATEGORY
 EFYA -- ENLISTMENTS FOUR YEARS AGO

A DNORM.K=MAX(REEN.K/CONR.K,0)*ENLSTM.K (B-17)

DNORM -- DEMAND TO ADJUST CAREER FORCE
 REEN -- DESIRED GAINS INTO YEAR GROUP 5
 CONR -- FIRST TERM CONTINUATION RATE
 ENLSTM -- MULTIPLIER FOR ENLST - MGT POLICY

To determine the continuation rate, the number of personnel eligible to reenlist is divided by the number that enlisted four years ago. To obtain the number of accessions four years ago, the SHIFTL command and a 16-element array, PIP, are used. The PIP array contains the enlistments for the last 16 quarters. At each time period, the number of enlistments for that period is stored in the first element of the array PIP. Also at each time period, the SHIFTL command shifts each element of the

A EFYA.K=SHIFTL(PIP.K,1) (B-18)

EFYA -- ENLISTMENTS FOUR YEARS AGO
PIP -- PIPELINE OF ENLISTMENTS

L PIP.K(1)=PIP.J(1)+DT*ENLST.J

PIP -- PIPELINE OF ENLISTMENTS
ENLST -- INITIALIZATION OF ENLISTMENTS

N PIP(FY)=PIPI(FY)

PIP -- PIPELINE OF ENLISTMENTS
PIPI -- INITIAL PIPELINE OF ENLISTMENTS FROM LAST 4 YEARS

array PIP by one element. The sixteenth element is shifted out and stored in EFYA, which represents the number of accessions that occurred 16 periods (quarters) ago.

A multiplier, ENLSTM, is placed on the normal demand equation (DNORM) to simulate management adjustments to the total force size. The value of the multiplier varies according to the curve depicted in Figure B-5.

A ENLSTM.K=TABHL(TEM,SMOOTH(TOTF.K/FORCE.K,4),.8,1.2,.1) (B-19)

ENLSTM -- MULTIPLIER FOR ENLST - MGT POLICY
FORCE -- PERSONNEL AUTHORIZED IN THE ENLISTED FORCE
TOTF -- TOTAL ACTUAL ENLISTED FORCE
TEM -- TABLE OF ENLISTMENT MULTIPLIERS

T TEM=1.2/1.15/1.0/.85/.8

The shape of the curve indicates rapid adjustment will be made in small force discrepancies and less rapid adjustments in large discrepancies.

During a large force drawdown (greater than 40,000 per year), force managers allow the career force to deviate from the desired profile and

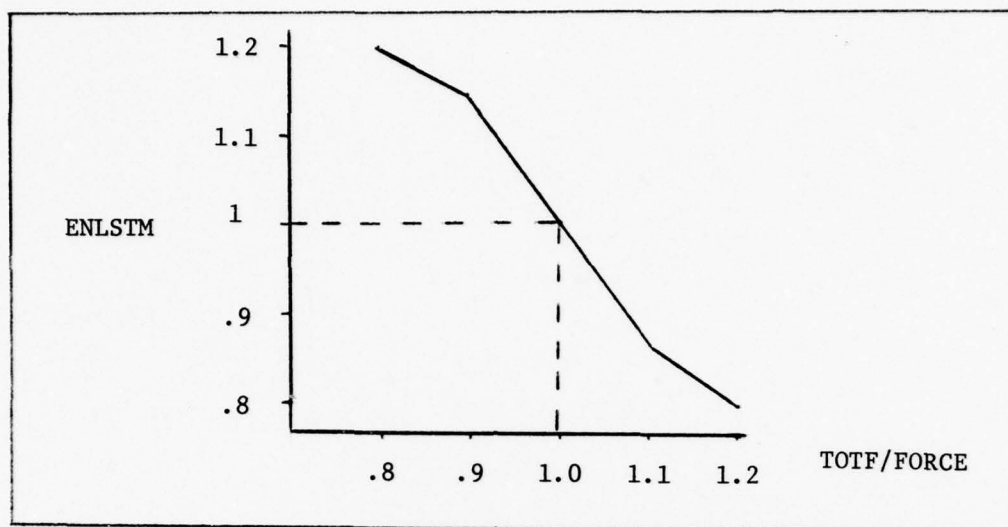


Figure B-5. Enlistment Management Multiplier

concentrate on meeting authorized total force levels. The demand equation under force drawdowns is formulated as follows:

$$A \quad DFDD.K = \text{MAX}(FDSC.K / FADT + \text{SMOOTH}(TATT.K, AST) + \text{SMOOTH}(TRET.K, AST) \quad (B-20)$$

$$X \quad \text{SMOOTH}(\text{SUM}(FOA5.K), AST), 0)$$

DFDD -- DEMAND TO ADJUST FOR TOTAL FORCE OBJECTIVE
 FDSC -- TOTAL FORCE DISCREPANCY
 TATT -- TOTAL ATTRITIONS
 TRET -- TOTAL RETIREMENTS
 FOA5 -- FORCE OUTS AT FIVE YEAR POINT

The main difference between DFDD and DNORM is that in DFDD, adjustment is made for total force parameters (FDSC, TATT, and TRET) and in DNORM, adjustment is made for career force parameters (CFDSC, CATT, and CRET).

The constant FOD is used in the program to specify which demand equation to use. If FOD is greater than zero, DNORM is used, and if FOD is less than zero, DFDD is used.

A DEMAND.K=CLIP(DNORM.K, DFDD.K, FOD, 0)

(B-21)

DEMAND -- DEMAND FOR RECRUITS

In development of the model, it was assumed that the supply of new recruits was adequate to meet force demands. In order to investigate possible shortfalls in meeting quality enlistment goals, however, the labor market supply of 17-21 year old males was simulated. Population and high school graduate statistics to the year 2010 were obtained from Cooper's report on the all volunteer force (Ref 9:90). Total enlistment supply (SUPPLY) was structured as the sum of the supply of high school graduates (SUPA) and non-high school graduates (SUPB). The supply of high school graduates is assumed to be a function of the normal (expected) recruiting percentage, unemployment rate, and the ratio of military to civilian wage indexes. Formulation of the supply equations is shown below:

A SUPPLY.K=SUPA.K+SUPB.K (B-22)
 SUPPLY -- SUPPLY OF 17 - 21 YEAR OLD MALES
 SUPA -- SUPPLY OF HIGH SCHOOL GRADUATES
 SUPB -- SUPPLY OF NON-HIGH SCHOOL GRADUATES

A SUPB.K=(POP.K-HSG.K)*.25 (B-23)
 SUPB -- SUPPLY OF NON-HIGH SCHOOL GRADUATES
 POP -- POPULATION POOL
 HSG -- HIGH SCHOOL GRADUATES

A SUPA.K=HSG.K*NRN*UM.K*WM.K*.25 (B-24)
 SUPA -- SUPPLY OF HIGH SCHOOL GRADUATES
 NRN -- NORMAL (EXPECTED) RECRUITING PERCENTAGE
 QM -- QUALITY MULTIPLIER
 HSG -- HIGH SCHOOL GRADUATES
 WM -- WAGE MULTIPLIER
 RM -- RECRUITING MULTIPLIER
 UM -- UNEMPLOYMENT MULTIPLIER

The supply of non-high school graduates (SUPB) accounts for the assumption of unlimited supply in the model.

Both SUPA and SUPB are multiplied by .25 to give quarterly supply statistics. No attempt was made in the model to diminish enlistment supply by the number of personnel enlisted each quarter.

The expected recruiting percentage (NRN) of high school graduates was based on 1978 data. In the model, the unemployment rate used is six percent. Reaction of total enlistments to changes in the unemployment rate is hypothesized by the curve shown in Figure B-6.

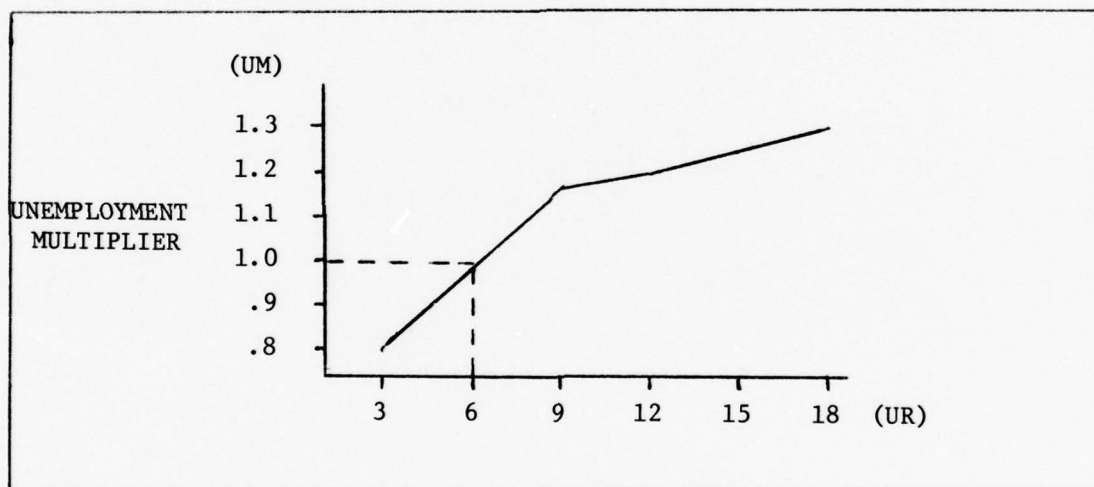


Figure B-6. Multiplier for Unemployment Rate

The wage multiplier (WM) was formulated in a table function based on the ratio of military to civilian wage indexes. Formulation of the reaction of possible enlistees to this ratio is depicted in Figure B-7.

The number of high school graduates enlisted was formulated to be the minimum of the supply of high school graduates (SUPA) and the total accession demand (DEMAND):

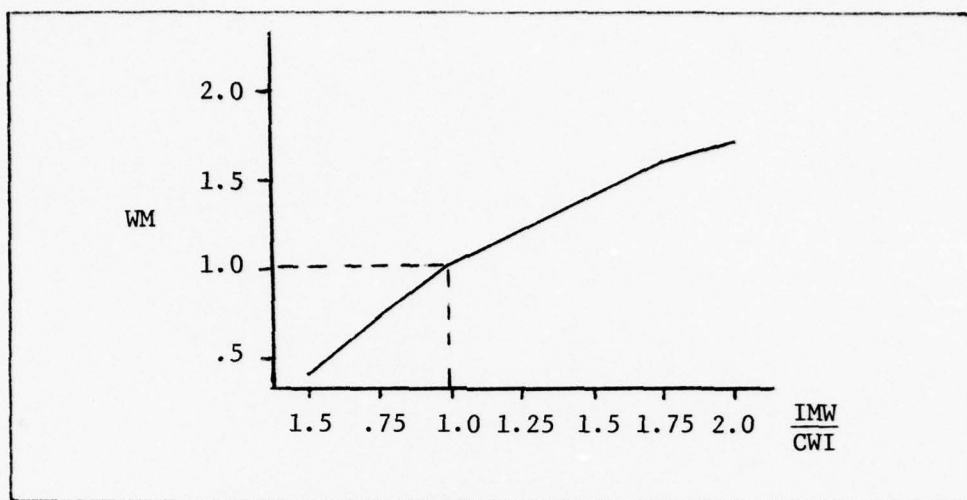


Figure B-7. Supply Wage Multiplier

$$A \quad \text{HSGE.K} = \text{MIN}(\text{SUPA.K}, \text{DEMAND.K}) \quad (\text{B-25})$$

HSGE -- HIGH SCHOOL GRADUATES ENLISTED
 SUPA -- SUPPLY OF HIGH SCHOOL GRADUATES
 DEMAND -- DEMAND FOR ENLISTEES

In order to track the percentage of non-high school enlistees to total enlistments (PNHSE), the following equations were formed:

$$A \quad \text{NHSGE.K} = \text{MAX}(\text{DEMAND.K} - \text{HSGE.K}, 0) \quad (\text{B-26})$$

NHSGE -- NON-HIGH SCHOOL GRADUATES ENLISTED
 DEMAND -- DEMAND FOR NEW ENLISTEES
 HSGE -- HIGH SCHOOL GRADUATES ENLISTED

$$A \quad \text{PPNHSE.K} = \text{NHSGE.K} / \text{ENLST.K} \quad (\text{B-27})$$

PNHSE -- PERCENT NON-HIGH SCHOOL GRADUATES ENLISTED
 NHSGE -- NON-HIGH SCHOOL GRADUATES ENLISTED
 ENLST -- ENLISTMENTS INTO THE FORCE

Considerations for recruiting effort, enlistment bonuses, and other management directed actions are omitted in computation of the supply of enlistees. The primary purpose of the supply section is to measure the

effectiveness of management policies in attracting quality personnel (high school graduates) into the force.

The reenlistment point for purposes of this model is at the beginning of the fifth year of service. As mentioned earlier in this section, reenlistees are selected from those eligible to age into the fifth year group, on the basis of rank. That is, eligible personnel with higher rank are reenlisted before those of a lower grade. The reenlistment process continues down through the grade structure until the reenlistment goal is reached. This is incorporated in the model by the following equations:

$$\begin{array}{ll} \text{A} & \text{REUP.K(TOP)} = \text{MAX}(\text{MIN}(\text{REEN.K, AGE.K(9, 5)}), 0) \\ \text{A} & \text{REUP.K(GDL)} = \text{MAX}(\text{MIN}(\text{REEN.K} - \text{SUMV}(\text{REUP.K(*)}, \text{GDL}+1, \text{TOP}), \\ \text{X} & \text{AGE.K(GDL, 5)}), 0) \end{array} \quad (\text{B-28})$$

GAINS -- RATES AT WHICH PERSONNEL ENTER
EACH GRADE/YEAR CATEGORY
AGE -- RATE OF AGEING INTO EACH GRADE/AGE CATEGORY
PR -- PROMOTIONS INTO GRADE/AGE CATEGORY
REUP -- REENLISTMENTS BY GRADE
REEN -- DESIRED GAINS INTO YEAR GROUP 5
ENLST -- ENLISTMENTS INTO FORCE

Attrition Flow. Attritions are defined as those departures from military service brought about by individuals' free and rational choice or by involuntary dismissals by the services for cause. Attrition does not include retirement, which is handled separately in this model. Attritions may be due to such things as job dissatisfaction, poor career progression, attractiveness of jobs in the civilian environment, or improper or illegal actions on the part of the individual. In the past, prediction of attrition has been based mainly on simple extrapolation of past trends. Frequently, the implications of these predictions have been lost in the complexity of the interactions in the personnel system.

An understanding of the dynamic interactions in the system can enable force managers to effectively use these predictions and possibly design alternative policies to minimize the adverse affects of perturbations in the system.

The attrition rate is one indication of the relative attractiveness of military versus civilian careers. The strength of this rate affects the ability of the system to meet promotion opportunity goals as well as the number accessions required to meet force level objectives. Naturally, there are significant cost implications tied to the turnover rate in a personnel system. If turnover rate increases, then the cost of training will increase. Conversely, a decrease in attritions beyond a certain point can cause undesirable promotion stagnation.

Attritions are a function of many variables, as mentioned earlier. Three variables have been identified which would apply to most individuals and almost certainly to the group as a whole. It is not the goal of the model to predict attritions, but rather to indicate the direction of the movement in attritions due to changes in these variables. Variables were chosen that represent three areas over which the military and Congressional system have direct control; and therefore are endogenous to the system in question. These variables are (1) promotion opportunity, (2) military to civilian wage ratio, and (3) retirement benefits. A function for attritions is then formulated as:

$$ATT = F (\text{Promotional Opportunity, Military/Civilian Wage, Retirement Benefits, Miscellaneous Variables})$$

In this model, the miscellaneous variables, such as educational benefits are assumed fixed. The hypothesized direction of change in

ATT are:

$\frac{\partial F}{\partial PO}$	< 0	As promotional app (PO) improves, ATT decreases
$\frac{\partial F}{\partial \frac{MW}{CW}}$	< 0	As military wage relative to civilian wage $\frac{MW}{CW}$ increases, ATT decreases
$\frac{\partial F}{\partial RB}$	< 0	As retirement benefits (RB) increase, ATT decreases

An absolute magnitude for changes is hypothesized to act as a starting point from which sensitivity analysis is conducted.

The attrition equations are presented below:

$$\begin{aligned} A \quad & ATT.K(GD, YRC) = MAX(MEN.K(GD, YRC) * ATTMP.K(GD) * ATTM.K(GD, YRC) \\ X \quad & * ATTP.K(GD) * ATTRB.K * .25 * ATTN.K(GD, YRC), 0) \end{aligned}$$

(B-29)

$$\begin{aligned} A \quad & ATT.K(GD, F) = MAX(MEN.K(GD, F) * ATTMP.K(GD) * ATTM.K(GD, F) \\ X \quad & * ATTP.K(GD) * ATTRB.K * .25 * ATTN.K(GD, F), 0) \end{aligned}$$

ATT -- ATTRITION FROM EACH GRADE/AGE CATEGORY
 MEN -- PERSONNEL IN EACH GRADE/AGE CATEGORY
 ATTMP -- ATTRITION MULTIPLIER - MILITARY PAY
 ATTRB -- ATTRITION MULTIPLIER - RETIREMENT BENEFITS
 ATTN -- NORMAL ATTRITION FACTOR
 ATTM -- ATTRITION MULTIPLIER - MANAGEMENT POLICY
 FTATTP -- FIRST TERM ATTRITION PERCENTAGES

Attritions are computed as a normal percentage of the men in a level (ATTN and FTATTP). The variables that affect attritions are modeled as a string of multipliers (ATTMP, ATTP, ATTRB, and ATTM). In equilibrium, each of the multipliers has a value of one. Each multiplier will be discussed individually.

Multipliers from Promotion Opportunity. It is assumed that the promotion opportunity to the next grade will have the greatest

impact on individuals' decision to leave the military service. Since promotion through the grade E-4 is on a fully qualified basis, attritions due to promotion opportunity are assumed to affect only those who will be promoted to E-5 through E-9. For example, attritions from grade E-5 will be a function of the promotion opportunity to grade E-6. The structural form of the multipliers for promotion opportunity are identical for grades E-4 through E-8. The grade E-8 attrition multiplier will be discussed to illustrate the process and assumptions involved.

Promotion opportunity to grade E-9 is formed as the ratio of promotions to E-9 to the number of eligible men to promote to E-9. These quantities are defined below:

```
A  P.K(1)=0
A  P.K(GDU)=SUMV(PR.K(GDU,*),1,OLD)
      P      -- PROMOTIONS BY GRADE
```

(B-30)

```
A  MENTP.K(1,YR)=0
A  MENTP.K(GDU,YR)=MAX(MEN.K(GDU-1,YR)-ATT.K(GDU-1,YR),0)
X  *PET(GDU,YR)
```

(B-31)

```
MENTP  -- MEN AVAILABLE TO PROMOTE
MEN     -- PERSONNEL IN EACH GRADE/AGE CATEGORY
AGE     -- RATE OF AGEING INTO EACH GRADE/AGE CATEGORY
ATT     -- ATTRITION FROM EACH GRADE/AGE CATEGORY
```

```
A  SMENTP.K(1)=0
A  SMENTP.K(GDU)=SUMV(MENTP.K(GDU,*),1,OLD)
```

(B-32)

```
SMENTP -- MEN AVAILABLE TO PROMOTE BY GRADE
GDU     -- GRADES E2 AND E9 (2,9)
AVTP    -- AVERAGE TIME TO PROMOTE ( QTR )
```

A one-year exponential average of this ratio is used to simulate a perception delay. The multiplier for promotion opportunity to grade E-9 can now be derived from a table function which uses the ratio of

promotions to grade (P) and men eligible to promote to grade (SMENTP)
as the independent variable:

```
A  ATTP.K(8)=CLIP(TABHL(TPO9,SMOOTH(P.K(9)*4/SMENTP.K(9),4),
X    .0835,.1135,.005),1.0,TIME.K,4)
```

(B-33)

```
ATTP  -- ATTRITION MULTIPLIER - PROMOTION
PRTG  -- PROMOTIONS TO GRADE
GPROF -- TOTAL MEN IN A GRADE
```

```
T  TPO9=1.05/1.02/1.01/1.0/.99/.98/.95
```

In figure B-8, a promotion opportunity ratio of .0985 yields
equilibrium; consequently, $ATTP.K(9) = 1$.

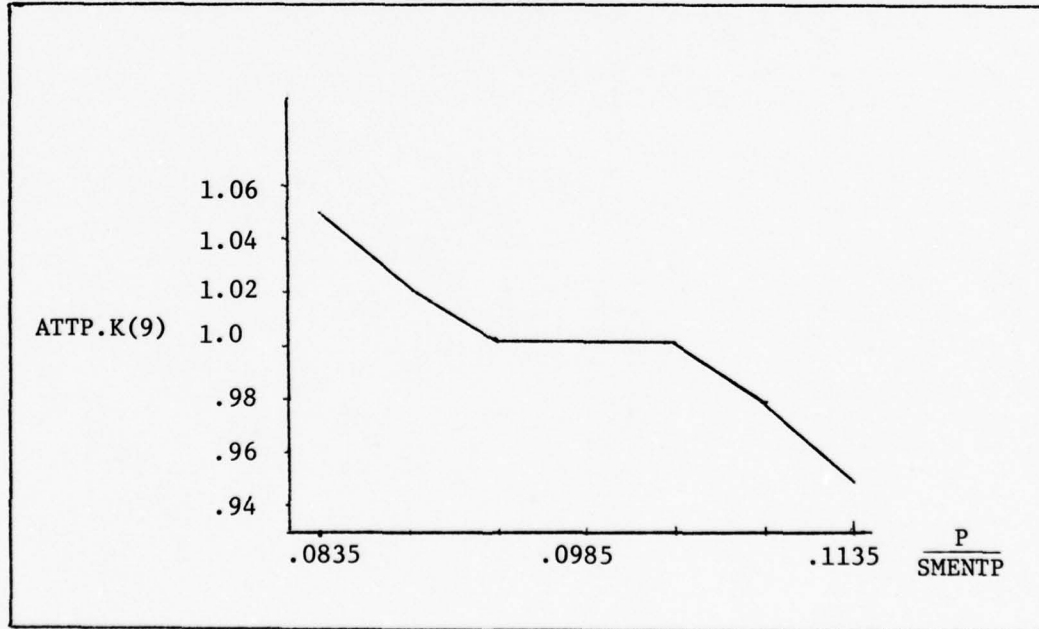


Figure B-8. Multiplier from Promotion Opportunity

Ratios lower than .0985 represent lower promotion opportunity and ratios higher than .0985 represent higher promotion opportunity.

The elasticity of attritions due to promotion opportunity is not known; consequently, the shape and slope of the curves used in the table functions are hypothetical and subject to sensitivity analysis. Relative elasticities between different grades can be reasonably hypothesized. It was assumed that E-4's would be the most sensitive to promotion opportunity, and E-5's and E-6's somewhat less. The reactions of E-7's and E-8's were considered very mild. As different retirement proposals are considered with this model, the analyst will have to reassess the relative slopes used in determining the promotion opportunity multipliers. For instance, under a fully vested retirement system, one could reasonably assume that E-4's would be less sensitive to promotion opportunity.

Multipliers for Military Pay. Several broad assumptions were made in order to incorporate a feedback loop between military pay and attritions. There exists an attrition rate associated with the system when it is in equilibrium. Two assumptions are (1) that attainment of these rates is a goal of the system and (2) that military pay is a viable incentive for adjustment of voluntary separation rates. In particular, the ratio of military wage to civilian wage is used to formulate this multiplier.

There are two basic hypotheses involved in the formulation of multipliers from military pay. First, sustained increases in purchasing power relative to the civilian sector will cause an overall reduction in voluntary attritions. Similarly, decreases in the military to civilian wage ratio will cause an increase in voluntary attritions. Second, military pay increases strive for parity with the civilian aggregate

unless there is some desired change in the voluntary attrition rates. For simplicity, two assumptions were made to incorporate these hypotheses: (1) a zero growth rate is simulated with an annual inflation rate of five percent and (2) the aggregate civilian wage index (CWI) is tied directly to the consumer price index (CPI). The CPI and CWI are both started at one in the first year and increased at a constant rate of .05 annually (.05 * .25 quarterly). An index for military wage (IMW) is also started in the first year and increased at .05 annually as long as voluntary attritions are at the desired rates. If separations are lower than desired, the IMW is increased at a rate less than .05 annually in order to increase voluntary attritions. If attritions are higher than desired, the IMW is increased at a rate greater than .05 in order to slow voluntary attritions.

It is also assumed that, with respect to their response to wage changes, the reactions of the force can be grouped into three homogeneous groups as follows: grades E-1 to E-3, grades E-4 to E-6, and grades E-7 to E-9. The equation structure is the same for each group and will be illustrated with the E-1 to E-3 group.

The consumer price index with the first year as a base year is calculated as follows:

$$L \quad CPI.K = CPI.J + DT * (IINF.JK) \quad (B-34)$$

CPI -- CONSUMER PRICE INDEX
IINF -- INCREASE IN INFLATION

$$R \quad IINF.KL = INF * CPI.K * .25 \quad (B-35)$$

IINF INCREASE IN INFLATION
CPI -- CONSUMER PRICE INDEX
INF -- INFLATION RATE

These equations represent a CPI which is exponentially increasing by a constant rate of inflation.

The civilian wage index is represented as:

$$A \quad CWI.K = CPI.K * (1 + AMP * SIN(6.28 * TIME.K / PER)) \quad (B-36)$$

CWI -- CIVILIAN WAGE INDEX
CPI -- CONSUMER PRICE INDEX

The expression in parentheses allows the CWI to cycle around the CPI rather than be tied directly to it.

The index for military wage (IMW) is constructed similar to the CPI except that the growth rate doubling time is not necessarily constant and therefore the growth is not exponential.

$$L \quad IMW.K = IMW.J + (MWI.JK) * DT \quad (B-37)$$

IMW -- INDEX MILITARY WAGE
MWI -- RATE OF INCREASE IN MILITARY WAGE

$$R \quad MWI.KL = FMWI.K * IMW.K * .25 \quad (B-38)$$

MWI -- RATE OF INCREASE IN MILITARY WAGE
IMW -- INDEX MILITARY WAGE
FMWI -- FRACTIONAL IMW

FMWI determines the rate of growth in the index for military wage. FMWI represents the annual increase in military wages, and is dependent on the voluntary separations from the system in the first 8 years of service. The voluntary separations must be calculated as a percentage of the total force:

$$A \quad FATT.K = SUMV(VATT.K(GD, *), 1, 8) / SUM(MEN.K) \quad (B-39)$$

FATT -- FRACTIONAL VOLUNTARY ATTRITIONS
ATT -- ATTRITION FROM EACH GRADE/AGE CATEGORY
MEN -- PERSONNEL IN EACH GRADE/AGE CATEGORY

$$A \quad SATT.K = SMOOTH(FATT.K, 8)$$

SATT is used as the final input for determination of the wage increase (FMWI) in order to incorporate a delayed response of pay to attritions.

FMWI is calculated from a table function using FATT as the dependent variable:

(B-40)

In Figure B-9, a fractional voluntary attrition of .0005156 yields equilibrium; consequently, FMWI = .05, resulting in the same growth rate for IMW as that for CWI. The slope of the curve derived from the FMWI table function is an hypothesis.

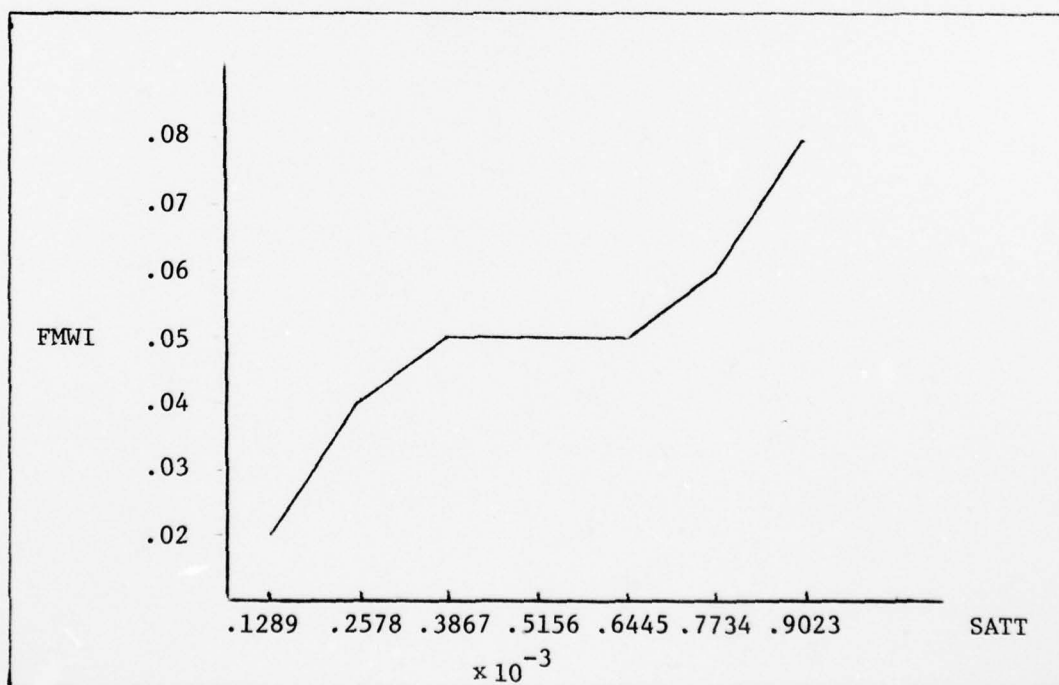


Figure B-9. Responsiveness of Military Pay to Voluntary Separations

The multiplier for military pay can now be derived for each group of grades from a table function which uses the ratio of IMW and CWI as the independent variable:

A $ATTMP.K(X) = TABHL(TMP1, SMOOTH(IMW.K/CWI.K, 8), .5, 2.0, .25)$

(B-41)

ATTMP -- ATTRITION MULTIPLIER - MILITARY PAY
CWI -- CIVILIAN WAGE INDEX
IMW -- INDEX FOR MILITARY WAGE

T $TMP1 = 1.25/1.10/1.0/.96/.90/.85/.78$

IMW/CWI is averaged over two years in order to provide a perception delay in index changes. A ratio of one implies parity between civilian and military wage and results in a multiplier of one (no change in voluntary separations due to military pay). A lower ratio will cause a higher voluntary attrition rate, and a high ratio produces a decrease in separations, as shown in Figure B-10.

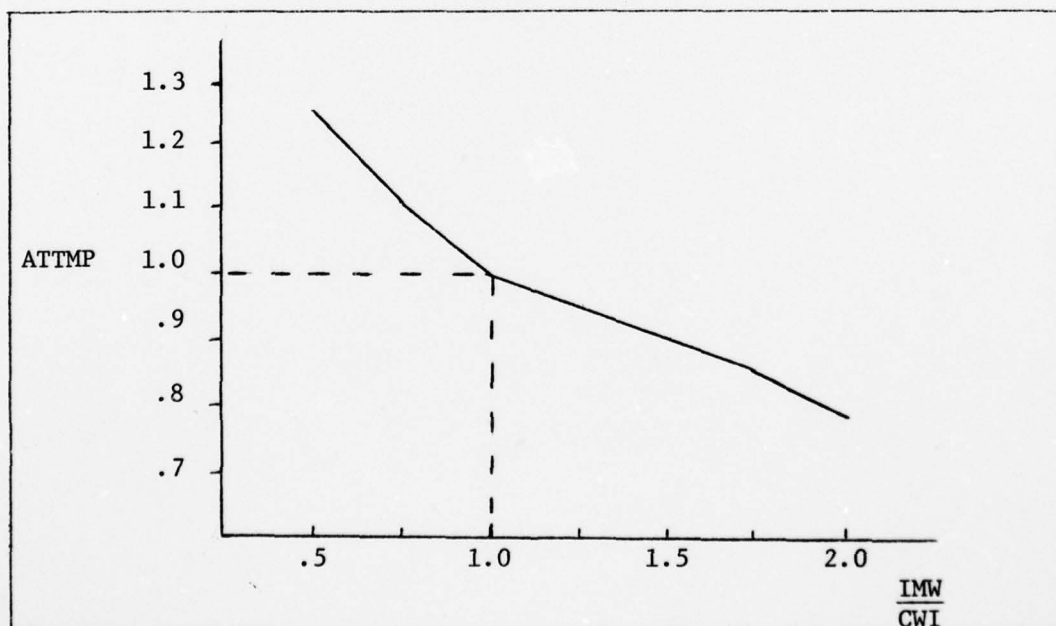


Figure B-10. Multiplier from Military Pay (ATTMP)

It is assumed that the responsiveness decreases as grade level increases.

Multipliers from Retirement Benefits. The third multiplier on voluntary attritions is an exogenous input. It is designed for use in evaluating different retirement proposals under various hypotheses on how each year group would react to a change in benefits. Year groups are aggregated into four categories based on similarities of response by individuals in those categories to different retirement proposals: (1) year groups 1 to 4 (F), (2) year groups 5 to 12 (M), (3) year groups 13 to 20 (year category 13), and (4) year groups 21 to 30 (N). These groupings follow those hypothesized in the President's Commission report. The multiplier can be used to induce a change in voluntary attritions due to any environmental change.

A	ATTRB.K(F)=1	
A	ATTRB.K(M)=1+STEP(HT1,ST1)	
A	ATTRB.K(13)=1+STEP(HT2,ST2)	
A	ATTRB.K(N)=1+STEP(HT3,ST3)	(B-42)

ATTRB -- ATTRITION MULTIPLIER - RETIREMENT BENEFITS

For force equilibrium, the HT and ST constants are set to zero. On subsequent runs, the step function can be activated to simulate a step increase or decrease in the multiplier from retirement benefits. For example, at time ST3, the step function changes ATTRB (for year categories 14 and 15) by HT3. This would simulate a percentage change in attritions due to retirement benefits.

Multipliers from Management Policy. It was assumed that force managers could, to some degree, affect the number of attritions in the lowest three grades. This can be done by allowing early outs during

times of force drawdowns or during times of force discrepancies to meet end strength objectives. Conversely, during periods of force buildups, managers can limit the number of attritions in the lower three grades.

First, the ratio of actual career force to authorized career force is formed. The multiplier is then derived from a table function with the ratio of TCARF and ACARF as the independent variable:

$$A \quad \text{ATTM.K(X, YR)} = \text{TABHL}(\text{TAM}, \text{SMOOTH}(\text{TCARF.K/ACARF.K}, 4), .92, 1.08, . \quad (\text{B-43})$$

ATTM -- ATTRITION MULTIPLIER - MANAGEMENT POLICY
TAM -- TABLE OF ATTRITION MULTIPLIERS
TCARF -- TOTAL ACTUAL CAREER FORCE
ACARF -- TOTAL AUTHORIZED CAREER FORCE

A ratio of one implies no discrepancy in the career force, resulting in a multiplier of one. As the graph in Figure B-11 shows, a ratio less than one results in higher attrition rates for grades E-1 to E-3 and a ratio greater than one results in a decrease in attritions in those grades. (Recall that the enlistment multiplier, ENLSTM, is used to adjust for total force discrepancies.) Again, the shape and slope of the curve in Figure B-11 is an hypothesis.

Promotion Flow. Promotion policy is a key instrument of the management process contained in the model. Much of the model's structure was designed to accommodate a fairly accurate representation of the promotion policy structure. Promotion policy is important to personnel managers for several reasons. First, it is a process for which definite goals are set (see Table VI) and performance is tracked. Secondly, due to the high visibility of promotion parameters to personnel and Congress,

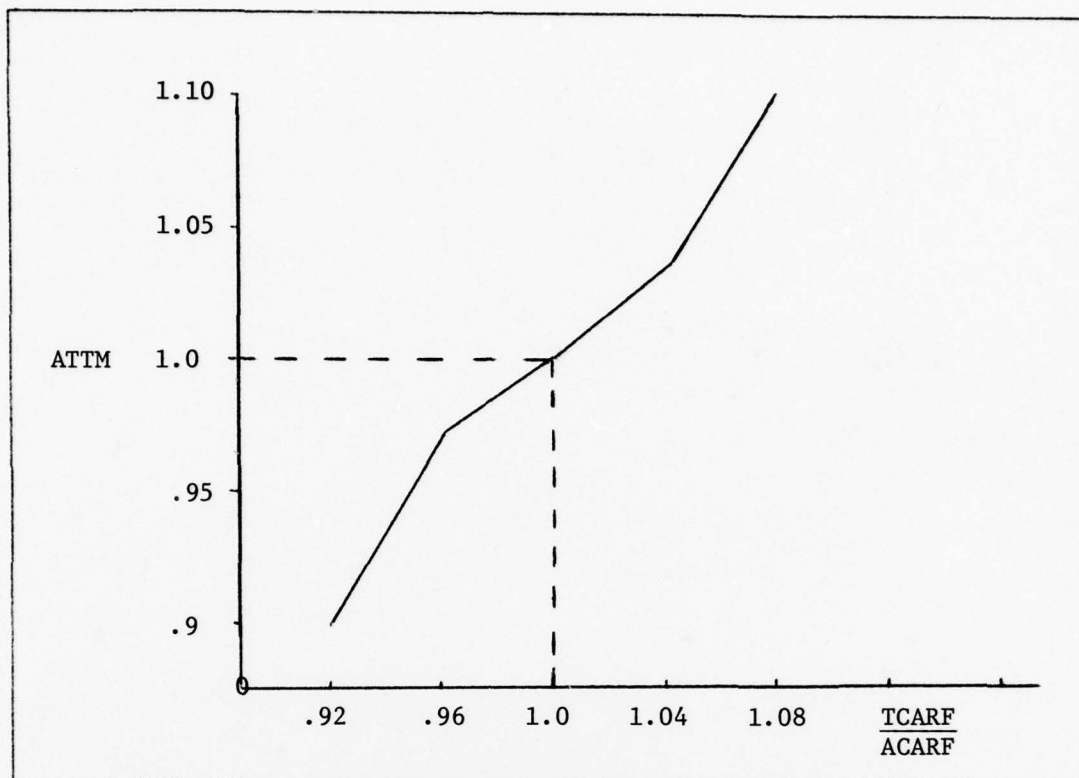


Figure B-11. Multiplier from Management Policy

the parameters are not allowed to vary indiscriminately. In addition, promotion opportunity enters into each individual's decision to continue or leave their military career at any given time.

In the model, it is assumed that promotion phase points are fixed. Promotion opportunity is measured indirectly as the ratio of actual promotions-to-grade to the number eligible to promote to grade.

The promotion rate in the lower grades (E-2 through E-4) is on a fully qualified basis. Promotions to these grades are allocated on a percentage basis with the largest percentage of promotions occurring at the TOPCAP phase point. The percentage in year-groups other than the phase point year (or quarter) simulates nonpromotions for cause (such as insufficient training or poor performance).

Promotions to the top five grades are determined by the number of vacant slots. As slots open up in the next higher grade, promotions are made to fill them. The number of promotions is distributed through the grade by year-group, with the majority of the promotions occurring in the TOPCAP "phase point" year (Table III).

Promotions to E-2 through E-4. As mentioned previously, promotions to grades E-2 through E-4 are on a fully qualified basis. First, the men available to promote to a grade (MENTP) in each grade-year category is determined. MENTP is computed as the number of men in the next lower grade after allowing for attritions from that grade. Also, it must be determined if the men in that category are eligible for promotion. This is done by using a promotion eligibility multiplier (PET). If the men in a particular grade-year group are not eligible for promotion, then that group's corresponding PET value will be zero; otherwise, it will be one. The columns of PET designate the promotion eligibility window for a grade. For example, promotion to grade E-4 may occur in any of the years 2 through 7. The men available to promote to each grade is then computed (B-47).

```
A  MENTP.K(1,YR)=0
A  MENTP.K(GDU,YR)=MAX(MEN.K(GDU-1,YR)-ATT.K(GDU-1,YR),0)      (B-44)
X    *PET(GDU,YR)
```

```
MENTP  -- MEN AVAILABLE TO PROMOTE
MEN     -- PERSONNEL IN EACH GRADE/AGE CATEGORY
AGE     -- RATE OF AGEING INTO EACH GRADE/AGE CATEGORY
ATT     -- ATTRITION FROM EACH GRADE/AGE CATEGORY
```



```

T  PET(*,1)=0/1/1/0/0/0/0/0/0
T  PET(*,2)=0/1/1/1/0/0/0/0/0
T  PET(*,3)=0/1/1/1/0/0/0/0/0
T  PET(*,4)=0/1/1/1/1/0/0/0/0
T  PET(*,5)=0/0/0/1/1/0/0/0/0
T  PET(*,6)=0/0/0/1/1/1/0/0/0
T  PET(*,7)=0/0/0/1/1/1/0/0/0
T  PET(*,8)=0/0/0/0/1/1/0/0/0
T  PET(*,9)=0/0/0/0/1/1/1/0/0
T  PET(*,10)=0/0/0/0/1/1/1/0/0
T  PET(*,11)=0/0/0/0/1/1/1/0/0
T  PET(*,12)=0/0/0/0/1/1/1/1/0
T  PET(*,13)=0/0/0/0/1/1/1/1/1
T  PET(*,14)=0/0/0/0/0/1/1/1/1
T  PET(*,15)=0/0/0/0/0/0/0/1/1

```

(B-45)

PET -- PROMOTION ELIGIBILITY MULTIPLIER

```

A  SMENTP.K(1)=0
A  SMENTP.K(GDU)=SUMV(MENTP.K(GDU,*),1,OLD)

```

SMENTP -- MEN AVAILABLE TO PROMOTE BY GRADE
 GDU -- GRADES E2 AND E9 (2,9)
 AVTP -- AVERAGE TIME TO PROMOTE (QTR)

(B-46)

The number of promotions to a specific grade-year category can now be determined.

```

A  PRC.K(1,YR)=0
A  PRC.K(GFT,YR)=SMENTP.K(GFT)*PALLOC(GFT,YR)/AVTP(GFT,YR)
A  PRC.K(GCR,YR)=MAX(PALLOC(GCR,YR)*DPR.K(GCR),0)

```

(B-47)

PRC -- PROMOTION RATE COMPUTED
 PALLOC -- PROMOTION ALLOCATIONS TO AGE GROUPS
 DPR -- DESIRED PROMOTIONS

PALLOC is used to allocate promotions to a particular year-group based on TOPCAP phase points. For example,

```

T  PALLOC(*,1)=0/.80/.15/0/0/0/0/0/0
T  PALLOC(*,2)=0/.19/.75/.133/0/0/0/0/0
T  PALLOC(*,3)=0/.007/.07/.557/0/0/0/0/0
T  PALLOC(*,4)=0/.003/.03/.310/.49/0/0/0/0

```

(B-48)

80 percent of the promotions to E-2 will occur in the first year-group; 19 percent in the second year-group, and so on. The array AVTP is used to determine the average time in that year-group until promotion. For example, the average time to promotion to E-2 is 9 months. AVTP (2,1) is 3. This means that on the average, one-third of the promotions to E-2 in the first year, will occur each quarter so that in three quarters you promote all of those people allocated to that year-group. Anyone not promoted to E-2 in their first year is promoted in the first quarter of their second year (AVTP(2,2) = 1).

T AVTP(*,1)=0/3/3/1
T AVTP(*,2)=0/1/1/4
T AVTP(*,3)=0/1/1/3
T AVTP(*,4)=0/1/1/1

(B-49)

The average time to promotion to E-3 is 15 months. There will be some promotions before this time and also some later. Most of the promotions (75%) will be at the end of the first quarter of the second year of service. Therefore, AVTP (3,2) is one. This means that on the average everyone (allocated to be promoted in that year-group) will be promoted after the first quarter. Promotions to E-3 before the second year are spread out over the year (AVTP(3,1) = 3) and anyone promoted in the third year is promoted at the end of the first quarter.

The average time-to-promote to E-4 is 2.7 years (approximated as 2.75 years) but promotions may occur before and after this point. The majority of promotions to E-4 occur during the third year of service (55.7%). AVTP (4,3) is three which indicates that one-third of the promotions to E-4 (in the third year-group) will occur each quarter so

that in three quarters, all of those people allocated to that year-group are promoted. Promotions to E-4 in the fourth year are assumed to take place after the first quarter.

After computing PRC, each grade-year category is tested to see if the computed number of personnel in that category is actually available to promote. This is done with a CLIP function:

```

A  PRI.K(GD,YR)=CLIP(PRC.K(GD,YR),MENTP.K(GD,YR),MENTP.K(GD,YR)
X  ,PRC.K(GD,YR))
    PRI  -- INITIAL PROMOTIONS INTO GR/AGE CATEGORY
    PRC  -- PROMOTION RATE COMPUTED
    MENTP -- MEN AVAILABLE TO PROMOTE
    MEN  -- PERSONNEL IN EACH GRADE/AGE CATEGORY
    DPR  -- DESIRED PROMOTIONS
    ATT  -- ATTRITION FROM EACH GRADE/AGE CATEGORY
    AGE  -- RATE OF AGEING INTO EACH GRADE/AGE CATEGORY

```

(B-50)

PRI is the final promotion rate to grades E-2 through E-4. For grades E-5 through E-9, PRI is an initial promotion rate, and the final promotion rate (PR) consists of PRI plus an incremental promotion rate, PRF. PRF will be discussed later in conjunction with promotions to grades E-5 through E-9.

Promotions to E-5 through E-9. As mentioned before, promotions to the top five grades is on a fully qualified basis to available slots. The number of slots in a particular grade is computed as a percentage of the total authorized force:

```

A  SLOTS.K(GD)=FORCE.K*GDPROF.K(GD)
    SLOTS  -- AUTHORIZED STRENGTH LEVELS BY GRADE
    FORCE   -- PERSONNEL AUTHORIZED IN THE ENLISTED FORCE
    GDPROF -- ENLISTED GRADE PROFILE

```

(B-51)

The grade profile is input as the initial force profile (see Appendix D for explanation and description of INPROF).

The desired promotion rate must account for the discrepancy between

A GDPF.K(GD)=INPROF(GD)+TEST2.K(GD)

(B-52)

GDPF -- ENLISTED GRADE PROFILE
 INPROF -- INITIAL TARGET FORCE PROFILE
 TEST2 -- TEST ON GRADE PROFILE

T INPROF=0/0/0/0/.204852/.106288/.0676367/
 X .0193255/.00966279

INPROF -- INITIAL TARGET FORCE PROFILE

the slots available in a grade and the men in that grade as well as those who will leave that grade by promotion to the next grade, retirement, and attrition. The desired promotion rate (DPR) is formulated as follows:

A DPR.K(F)=0
 A DPR.K(TOP)=SLOTS.K(TOP)-SUMV(MEN.K(TOP,*),1,OLD)+
 X SUMV(ATT.K(TOP,*),1,OLD)+SUMV(RET.K(TOP,*),1,OLD)
 A DPR.K(PRU)=SLOTS.K(PRU)-SUMV(MEN.K(PRU,*),1,OLD)+
 X SUMV(ATT.K(PRU,*),1,OLD)+SUMV(RET.K(PRU,*),1,OLD)+
 X SUMV(PRI.K(PRU+1,*),1,OLD)

(B-53)

DPR -- DESIRED PROMOTIONS
 ATT -- ATTRITION FROM EACH GRADE/AGE CATEGORY
 RET -- RETIREMENTS FROM EACH GRADE/AGE CATEGORY
 MEN -- PERSONNEL IN EACH GRADE/AGE CATEGORY
 PR -- PROMOTIONS INTO GRADE/AGE CATEGORY
 SLOTS -- AUTHORIZED STRENGTH LEVELS BY GRADE

Promotions are allocated to different year-groups by the PALLOC array:

T PALLOC(*,5)=0/0/0/0/.30/0/0/0/0
 T PALLOC(*,6)=0/0/0/0/.15/.053/0/0/0
 T PALLOC(*,7)=0/0/0/0/.06/.075/0/0/0
 T PALLOC(*,8)=0/0/0/0/0/.097/0/0/0
 T PALLOC(*,9)=0/0/0/0/0/.115/.005/0/0
 T PALLOC(*,10)=0/0/0/0/0/.126/.011/0/0
 T PALLOC(*,11)=0/0/0/0/0/.126/.024/0/0
 T PALLOC(*,12)=0/0/0/0/0/.115/.044/.0003/0
 T PALLOC(*,13)=0/0/0/0/0/.293/.863/.4827/.071
 T PALLOC(*,14)=0/0/0/0/0/0/.053/.517/.885
 T PALLOC(*,15)=0/0/0/0/0/0/0/0/.044

(B-54)

PALLOC -- PROMOTION ALLOCATIONS TO AGE GROUPS

The actual number promoted to a grade-year group is determined by comparing PRC and MENTP in a grade-year category. The CLIP function chooses PRC if there are enough men in that group or it chooses MENTP if the computed promotion rate exceeds the number of men available to promote.

A $PRI.K(GD, YR) = CLIP(PRC.K(GD, YR), MENTP.K(GD, YR), MENTP.K(GD, YR)$ (B-55)

X , $PRC.K(GD, YR)$)
 PRI -- INITIAL PROMOTIONS INTO GR/AGE CATEGORY
 PRC -- PROMOTION RATE COMPUTED
 MENTP -- MEN AVAILABLE TO PROMOTE
 MEN -- PERSONNEL IN EACH GRADE/AGE CATEGORY
 DPR -- DESIRED PROMOTIONS
 ATT -- ATTRITION FROM EACH GRADE/AGE CATEGORY
 AGE -- RATE OF AGEING INTO EACH GRADE/AGE CATEGORY

A $PRTG.K(GD) = SUMV(PRI.K(GD, *), 1, OLD)$ (B-56)

PRTG -- TOTAL INITIAL PROMOTIONS BY GRADE
 PRI -- INITIAL PROMOTIONS INTO GR/AGE CATEGORY

This process of distributing promotions may result in a total number of promotions to a grade less than the desired number of promotions.

A $PRDSC.K(GCR) = DPR.K(GCR) - PRTG.K(GCR)$ (B-57)

PRDSC -- PROMOTION DISCREPANCY BY GRADE
 DPR -- DESIRED PROMOTIONS
 PRTG -- INITIAL PROMOTIONS TO GRADE
 GCR -- GRADES E5 - E9

If there is a promotion discrepancy, then the assumed promotion policy is to promote the younger personnel available and eligible to be promoted. Specifically, additional personnel are promoted starting with those in the phase point year-group (for a particular grade) and proceeding to the younger year-groups until the promotion discrepancy for that grade is resolved. This formulation is implemented by the following equations and tables:

A PRF.K(GCR,OLD)=MAX(MIN(PRDSC.K(GCR),MENTP.K(GCR,OLD)-PRI.K(GCR,OLD)
X *PET2(GCR,OLD),0) (B-53)

PRF -- PROMOTIONS TO GRADE/YEAR TO ADJUST FOR
DESCREANCIES

PRDSC -- PROMOTION DESCREANCY BY GRADE

MENTP -- MEN AVAILABLE TO PROMOTE

PRI -- INITIAL PROMOTIONS INTO GRADE/YEAR CATEGORY

PET2 -- PREFERRED PROMOTION ELIGIBILITY MULTIPLIER

A PRF.K(GCR,YRL)=MAX(MIN(PRDSC.K(GCR)-SUMV(PRF.K(GCR,*),YRL+1,OLD)
X ,MENTP.K(GCR,YRL)-PRI.K(GCR,YRL))*PET2(GCR,YRL),0)

PRF -- PROMOTIONS INTO GRADE/YEAR CATEGORY TO ADJUST
FOR DESCREANCIES

PRDSC -- PROMOTION DESCREANCY BY GRADE

MENTP -- MEN AVAILABLE TP PROMOTE

PRI -- INITIAL PROMOTIONS INTO GRADE/YEAR CATEGORY

PET2 -- PREFERRED PROMOTION ELIGIBILITY MULTIPLIER

T PET2(*,1)=1/1/1/1/1/1/1/1/1/1

T PET2(*,2)=0/0/1/1/1/1/1/1/1/1

T PET2(*,3)=0/0/0/1/1/1/1/1/1/1

T PET2(*,4)=0/0/0/0/1/1/1/1/1/1

T PET2(*,5)=0/0/0/0/0/1/1/1/1/1

T PET2(*,6)=0/0/0/0/0/1/1/1/1/1

T PET2(*,7)=0/0/0/0/0/1/1/1/1/1

T PET2(*,8)=0/0/0/0/0/1/1/1/1/1

T PET2(*,9)=0/0/0/0/0/1/1/1/1/1

T PET2(*,10)=0/0/0/0/0/1/1/1/1/1

T PET2(*,11)=0/0/0/0/0/0/1/1/1/1

T PET2(*,12)=0/0/0/0/0/0/1/1/1/1

T PET2(*,13)=0/0/0/0/0/0/1/1/1/1

T PET2(*,14)=0/0/0/0/0/0/0/0/0/1

T PET2(*,15)=0/0/0/0/0/0/0/0/0/0

(B-59)

PET2 -- PREFERRED PROMOTION ELIGIBILITY MULTIPLIER

The first PRF equation is required to start the iterative process at the top year-group and work down. The PET2 multiplier allows only those year-groups in the phase point year (of the grade) and lower to be used to adjust for the discrepancy. In each year-group, the number of men remaining after the initial promotion pass is computed by MENTP.K(GD,YR) - PRI.K(GD,YR). The minimum of this number and the discrepancy in that grade (PRDSC) is chosen as the adjustment number of promotions for the

year. The process continues for lower year-groups until the PRDSC is corrected.

The total promotions to a grade/year-group then is defined as follows:

$$A \quad PR.K(GD, YR) = PRI.K(GD, YR) + PRF.K(GD, YR) \quad (B-60)$$

PR -- PROMOTIONS INTO GRADE/YEAR CATEGORY
PRI -- INITIAL PROMOTIONS INTO GRADE/YEAR CATEGORY
PRF -- PROMOTIONS INTO GRADE/YEAR CATEGORY TO ADJUST
 FOR DISCREPANCIES

Retirement Flow. Retirements consist of all separations from the service in year-groups 21-30 (categories 14 and 15). The number of retirements from each grade-year level is computed as a percentage of the personnel in that level. In the model, the retirement equation is formulated as a function of retirement benefits, promotion opportunity, and management policy. The number of retirements from each level is computed as follows:

$$A \quad RET.K(GD, YR) = MEN.K(GD, YR) * RETN.K(GD, YR) * ATTP.K(GD) * ATTMP.K(GD) \\ X \quad \quad * RETM.K * .25 \quad (B-61)$$

RET -- RETIREMENTS FROM EACH GRADE/AGE CATEGORY
MEN -- PERSONNEL IN EACH GRADE/AGE CATEGORY
RETM -- RETIREMENT MANAGEMENT POLICY MULTIPLIER
RETN -- NORMAL RETIREMENT FACTOR

RETN is a normal retirement percentage based on historical data. RETC represents the percentage of the personnel in each retirement eligible

$$A \quad RETN.K(GD, YR) = \min(4.0, RETC(GD, YR) + TEST4.K(GD, YR)) \quad (B-62)$$

RETN -- NORMAL RETIREMENT FACTOR
RETC -- RETIREMENT PERCENTAGES
TEST4 -- TEST ON RETIREMENT RATES

grade/year category who will retire each year. These percentages are formulated as tabled constants:

T RETC(*,14)=4.0/4.0/4.0/4.0/4.0/4.0/.495/.254/.152 (B-63)
T RETC(*,15)=4.0/4.0/4.0/4.0/4.0/4.0/4.0/.604/.369 (B-64)

RETC -- RETIREMENT PERCENTAGES

Since personnel may only retire from the last two year-group categories, the retirement percentages for year-groups 1 through 13 are zero. RETC equal to .495 in the (7,14) cell indicates that 49.5 percent of the personnel in grade E-7 will retire each year. In cell (7,15), RETC equal to 4.0 indicates that 100 percent of the personnel will be retired in one quarter. This corresponds to forced retirement at the high year of tenure for grade E-7.

The two attrition multipliers, ATTRB and ATTP, (in equation B-61) are designed to simulate the affect of a change in retirement benefits and promotion opportunity, respectively. These multipliers were discussed earlier in this Appendix.

RETM is used to formulate management policy affecting the size of the career force under force drawdown scenarios. Formulation of the multiplier is as follows:

A RETM.K=CLIP(1.0, FRETM.K, SMOOTH(CFDSC.K, 4), CCFD) (B-65)

RETM -- RETIREMENT MANAGEMENT POLICY MULTIPLIER
CFDSC -- CAREER FORCE DISCREPANCY
FRETM -- FORCED RETIREMENT MULTIPLIER
CCFD -- CRITICAL CAREER FORCE DISCREPANCY

Whenever the career force discrepancy exceeds a specified critical value (CCFD), retirements are increased, due to FRETM taking on values greater

than 1. The hypothesized management adjustment rate is depicted in Figure B-12.

A $FRET.M.K = TABHL(FRT, SMOOTH(CFDSC.K, 4)/CCFD, 1.0, 2.0, .25)$ (B-66)

FRET.M -- FORCED RETIREMENT MULTIPLIER
CCFD -- CRITICAL CAREER FORCE DESCREPANCY
CFDSC -- CAREER FORCE DESCREPANCY
FRT -- FORCED RETIREMENT MULTIPLIER TABLE

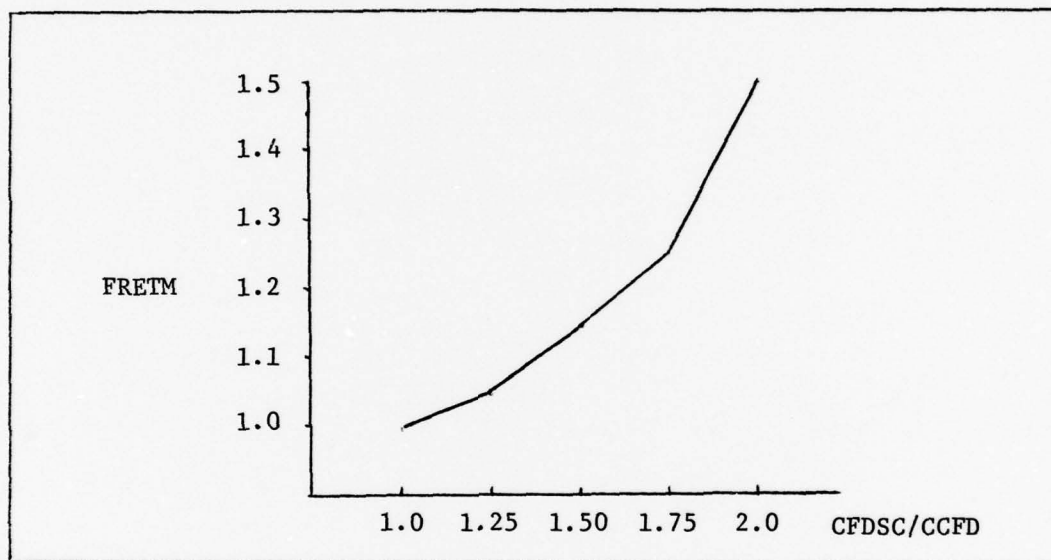


Figure B-12. Retirement Multiplier

Aging Flows. The aging equations handle the internal flows from one year-group to another. An individual is aged into the next year-group (of his current grade) if he does not attrite, retire, or get promoted. The time spent in a grade-year category is dependent on the size of the category. GPTIME is a vector which contains the time to age through each age category (by quarters).

T GPTIME=4/4/4/4/4/4/4/4/4/4/4/32/24/16

(B-67)

GPTIME -- TIME IN EACH AGE GROUP CATEGORY

The number who age into an E-9 year-group (TOP = 9) is the number of men in the previous year-group minus those who attrite or retire out of that year-group, divided by the time spent in that year-group.

The AGE equations for grades E-1 through E-8 are similar to Equation B-68. The difference is that the extra term for promotions to the next grade is also subtracted from the men who can age into a particular year-group.

A AGE.K(GD,1)=0

(B-68)

A AGE.K(TOP,YRU)=(MEN.K(TOP,YRU-1)-ATT.K(TOP,YRU-1)
X -RET.K(TOP,YRU-1))/GPTIME(YRU-1)

MEN -- PERSONNEL IN EACH GRADE/YEAR CATEGORY
ATT -- ATTRITIONS FROM EACH GRADE/YEAR CATEGORY
RET -- RETIREMENTS FROM EACH GRADE/YEAR CATEGORY
GPTIME -- TIME IN EACH YEAR GROUP CATEGORY

A AGE.K(GDL,YRU)=MAX((MEN.K(GDL,YRU-1)-ATT.K(GDL,YRU-1)
X -RET.K(GDL,YRU-1)-PR.K(GDL+1,YRU-1))/GPTIME(YRU-1),0)

AGE -- RATE OF AGEING INTO EACH GRADE/AGE CATEGORY
ATT -- ATTRITION FROM EACH GRADE/AGE CATEGORY
RET -- RETIREMENTS FROM EACH GRADE/AGE CATEGORY
GPTIME -- TIME IN EACH AGE GROUP CATEGORY
MEN -- PERSONNEL IN EACH GRADE/AGE CATEGORY

APPENDIX C

Costing

APPENDIX C

Costing

This appendix describes the methods and equations used for monitoring and accumulating the costs of the two retirement scenarios investigated in this report. The purpose of the costing module is not to provide specific cost estimates, but to allow relative cost comparisons under the two alternatives. Seven separate areas are costed: recruiting and initial processing, initial training, active duty pay, separation travel pay, retirement pay, deferred compensation pay, and involuntary separation pay. Each of these cost areas is explained below.

Costs for Recruiting and Initial Processing

This category includes an average recruiting cost per accession and initial permanent-change-of-station (PCS) cost. All the costs were obtained from the Office of the Assistant Secretary of Defense, Manpower and Reserve Affairs. The costs are estimated 1978 costs.

Recruiting cost is formulated as follows:

$$A \quad RC.K = (RCN * MFMPI.K + PCS) * ENLST.K * CPI.K \quad (C-1)$$

RC	-- RECRUITING COST
RCN	-- NORMAL RECRUITING COST
MFMPI	-- MULTIPLIER FROM MILITARY PAY
PCS	-- PERMANENT CHANGE OF STATION COST
ENLST	-- ENLISTMENTS
CPI	-- CONSUMER PRICE INDEX

It is assumed that the average recruitment cost per accession will be inversely related to the ratio of military to civilian pay. MFMPI is

computed as a table function of this ratio.

Initial Training Costs

Initial training costs are determined by computing an average cost per trainee:

$$\begin{aligned} \text{A} \quad \text{TRNC.K} &= \text{ENLST.K} * \text{CPI.K} * \text{ACPT.K} & (\text{C-2}) \\ \text{TRNC} & \text{-- TRAINING COSTS} \\ \text{ENLST} & \text{-- ENLISTMENTS} \\ \text{CPI} & \text{-- CONSUMER PRICE INDEX} \\ \text{ACPT} & \text{-- ACTUAL COST PER TRAINEE} \end{aligned}$$

$$\text{A} \quad \text{ACPT.K} = 8196 \quad (\text{C-3})$$

The average cost per trainee includes initial basic training cost (\$2293) plus an average cost for technical training (\$5903) received after completion of initial training.

It should be noted that the cost to train personnel for the many skills required in the enlisted force is quite varied. The ACPT is merely an attempt to capture the average cost across DOD.

Active Duty Pay

Active duty pay was computed for each grade using the annual composite standard rate from AFR 173-10. All rates were recomputed to indicate the five percent pay increase received in October 1978. These rates are shown in Table C-I.

Pay raises are accommodated using the index to military wage (IMW), which is explained in Appendix A. The equation for grade E-4 is:

$$\text{A} \quad \text{ADPE4.K} = \text{SUMV}(\text{MEN.K}(4,*), 1, \text{OLD}) * \text{STPE4} * \text{IMW.K} * .25 \quad (\text{C-4})$$

ADPE(X)- ACTIVE DUTY PAY BY GRADE PER QUARTER

TABLE C-I

Standard Pay Rates

<u>Grade</u>	<u>Annual Pay Rate</u>
E-1	\$ 6,993
E-2	7,750
E-3	8,378
E-4	10,349
E-5	11,793
E-6	13,857
E-7	16,072
E-8	18,517
E-9	21,718

C STPE4 = 10349

STPE(X) - ANNUAL COMPOSITE PAY BY GRADE

Separation Travel Costs

Separation travel pay is paid to anyone leaving active duty.

Formulation for separation travel cost is:

A $STC.K = SMOOTH(SUM(VATT.K) + SUM(FOA5.K), AST) * CPI.K * 715$ (C-5)

STC	-- SEPARATION TRAVEL COSTS
VATT	-- VOLUNTARY ATTRITIONS
FOA5	-- FORCE OUTS AT THE FIFTH YEAR POINT
AST	-- ATTRITION SMOOTH TIME
CPI	-- CONSUMER PRICE INDEX

The average termination PCS cost (\$715) for enlisted personnel was taken from AFR 173-10.

Retirement Costs

The differences in the two retirement policies complicated the retirement costing process. For ease in programming, two separate cost modules were constructed, both of which are compatible with the rest of the model. No provision is made to allow transition from the present system to the President's Commission plan. Cost comparisons are made between the two systems under full implementation. Retirement costs in the model are measured in constant 1978 dollars. For ease in presentation, the two cost modules will be discussed separately.

Present System. Retirement pay under the present system is given only to personnel who complete at least 20 years of service. Retirements occur from the last two year group categories (14 and 15); grades E-5 through E-9 are the only grades who are allowed to age into these year group levels. Formulation of retirement costs is as follows:

$$A \quad RP.K(GD,I) = BP.K(GD,I)*RETL.K(GD,I)*YOS(GD,I)*.025 \quad (C-6)$$

RP	-- RETIREMENT PAY BY GRADE
BP	-- QUARTERLY BASIC PAY
RETL	-- TOTAL MEN IN RETIREMENT BY GRADE
YOS	-- YEARS OF SERVICE

Retirement pay is equal to two and one-half percent of basic pay upon retirement (BP) multiplied by years of service (YOS) and the number of personnel in the retirement level (RETL). Since both year groups (14 and 15) are aggregations of years 21 to 26 and 27 to 30, respectively, it was necessary to designate a value for YOS to use in retirement computations. Table C-II lists the YOS values and basic pay used for computation purposes for each grade and year group. Retirement levels are necessary to account for the number of personnel in retirement at

TABLE C-II

Years of Service and Basic Pay for Retirement Computation

<u>Grade/Year Group</u>	<u>YOS</u>	<u>Basic Pay</u>
(5,14)	20	\$ 761
(6,14)	23	897
(7,14)	26	1,088
(8,14)	26	1,224
(8,15)	28	1,360
(9,14)	26	1,388
(9,15)	30	1,523

each time period. The level equation is:

$$L \quad RETL.K(GD,I) = RETL.J(GD,I) + DT*(RETR.JK(GD,I) - DR.JK(GD,I)) \quad (C-7)$$

RETL -- TOTAL MEN IN RETIREMENT BY GRADE
 RETR -- RETIREMENT RATE
 DR -- DEATH RATE

The retirement rate (RETR) is basically a fixed percentage (based on historical data) of the personnel in retirement eligible grade/year-group categories (see Appendix B). The rate out (DR) of the retirement level is the number of retired personnel who die. It was assumed that 72 years is the average age a retiree would live. The death rate is computed as:

$$R \quad DR.KL(GD,I) = RETL.K(GD,I)/ARTIME(GD,I) \quad (C-8)$$

DR -- DEATH RATE
 RETL -- TOTAL MEN IN RETIREMENT BY GRADE
 ARTIME -- AVERAGE TIME SPENT IN RETIREMENT

RETL represents the number of personnel in the particular retirement level, and ARTIME represents the expected time an individual will be in the retirement pool. ARTIME is calculated by adding the years of service (YOS) at retirement to 18 (assumed average age at enlistment) and subtracting this sum from 72 years. The death rate is an average rate out of the retirement level. Total retirement pay was calculated as the sum of the retirement costs paid for each level.

President's Commission Plan. The President's Commission recommended several changes be made in the military pay system, not just in retirement policies alone. A deferred compensation trust fund and involuntary separation pay are parts of the cost package presented as an alternative to the present retirement system.

Under the Commission plan, old age annuities are paid to personnel who complete ten or more years of service. The annuity begins at an age determined by the total number of years an individual remains in the military. Table C-III lists the age at which the annuity begins for the three categories of years-of-service. Though the actual cash outlays do not begin until retirees reach the appropriate annuity age listed in Table C-III, it is assumed in the model that cost accumulations and DOD budget transactions begin at the time of separation.

The size of the annuity is also a function of the years of service completed. Table C-IV shows the per-year multipliers recommended by the Commission according to YOS. Retirement pay is calculated using the following equation:

$$A \quad ZRP.K(GD,I) = BP.K(GD,I) * RETL.K(GD,I) * (.2125 + .0275 * (YOS(GD,I) - 10)) \quad (C-9)$$

TABLE C-III

Eligibility for Retirement Annuity

<u>YOS</u>	<u>Age Annuity Begins</u>
10-19 years	62
20-29 years	60
30 or more	55

TABLE C-IV

Annuity Multipliers

<u>YOS</u>	<u>Per-Year Multipliers (Percentage)</u>
1 to 5 years	2.00%
6 to 10 years	2.25%
11 to 35 years	2.75%

ZRP -- RETIREMENT PAY BY GRADE (PRESIDENT'S COMMISSION)
 BP -- QUARTERLY BASIC PAY
 RETL -- TOTAL MEN IN RETIREMENT BY GRADE
 YOS -- YEARS OF SERVICE

Retirement pay by grade and year-group (ZRP) is equal to basic pay upon retirement multiplied by the sum of .2125 (accumulated percentage multiplier for the first ten years) plus .0275 times the number of years-of-service completed above ten years. This number is multiplied

by the number of personnel in the specified retirement level (RETL).

Basic pay (BP) is formulated as follows:

$$A \quad BP.K(GD, I) = IBP(GD, I) * 3 \quad (C-10)$$

BP -- BASIC PAY
IBP -- INITIAL MONTHLY BASIC PAY
CPI -- CONSUMER PRICE INDEX

IBP represents the value of monthly basic pay at the start of the simulation, and is multiplied by three to give the quarterly value. If the model were run using another basic unit of time (i.e., annual), then IBP would be multiplied by some other constant.

The retirement levels under the Commission plan are formulated exactly like those under the present retirement system (see Equation C-7). Under the Commission retirement system, however, five year-group categories (11-15), instead of two, are eligible for retirement pay. The rate equation of personnel flowing into these levels reflects the difference in the size of the year-group categories affected:

$$R \quad RETR.KL(GD, I) = VATT.K(GD, I+10) \quad (C-11)$$

RETR -- RETIREMENT RATE
VATT -- VOLUNTARY ATTRITIONS

In the model, the retirement rate (RETR) is equivalent to the number of voluntary attritions (VATT). VATT is formulated as follows:

$$A \quad VATT.K(GD, YR) = ATT.K(GD, YR) + RET.K(GD, YR) \quad (C-12)$$

VATT -- VOLUNTARY ATTRITIONS BY GRADE
NVATT -- NONVOLUNTARY ATTRITIONS
ATT -- ATTRITIONS

Personnel can exit the active force only by attriting (ATT) or by retiring (RET). Those separating with over 10 years of service enter the retirement system.

The rate out (DR) of a retirement level is computed below:

$$R \quad DR.KL(GD,I) = RETL.K(GD,I)/ANUTIME(GD,I) \quad (C-13)$$

DR -- DEATH RATE
 RETL -- TOTAL MEN IN RETIREMENT BY GRADE
 ANUTIME-- NUMBER OF PERIODS ANNUITY IS PAID

ANUTIME represents the length of time an annuity is paid a retiree. It is calculated by subtracting the age at which the annuity begins (Table C-III) from 72 (assumed age of death), and then multiplied by four to represent the number of quarters the annuity is paid. ANUTIME is tabled for each retirement grade/year level. The following equation shows ANUTIME's for all grades in the 27-30 year groups.

$$T \quad ANUTIME(*,5) = 1/1/1/1/1/1/1/48/68 \quad (C-14)$$

The 1's actually represent zero lengths for annuity time but were used to avoid division by zero. According to equation (C-14), E-8's receive an annuity for an average of 48 periods (12 years) and E-9's for 68 periods (17 years).

The value of ANUTIME is divided into the number of personnel in the retirement level (RETL) to give an average rate out of the pool. Total retirement pay (TRP) is computed by summing retirement pay for each grade/year category.

$$A \quad TRP.K = SUM(ZRP.K) \quad (C-15)$$

TRP -- TOTAL RETIREMENT PAY
 ZRP -- RETIREMENT PAY BY GRADE (PRESIDENT'S COMMISSION)

TABLE C-V

Government Contribution to Deferred Compensation Account

<u>Years of Service</u>	<u>Percentage of Basic Pay</u>
6 to 10	20%
11 to 20	25%
21 to 26	15%
27 to 30	5%

21 to 26 year category, an E-8 with 23 years; and for the 27 to 30 year category, and E-9 with 28 years. Formulation of the amount for the first category (which is typical of the others) is shown below:

$$A \quad DCTF1.K = BP1.K * SUMV(MEN.K(GD,*), 6, 10) * ZPCT1 \quad (C-17)$$

DCTF1 -- DEFERRED COMPENSATION TRUST FUND (6-10 YEAR GROUP)
 BP1 -- QUARTERLY BASIC PAY (E5--8YEARS)
 ZPCT1 -- PERCENTAGE OF BASE PAY (6-10 YEAR GROUP)

$$A \quad BP1.K = 694 * 3 \quad (C-18)$$

BP1 -- QUARTERLY BASIC PAY (E5--8YEARS)

The total personnel in the 6 to 10 year group is multiplied by the percentage (ZPCT1) of basic pay (BP1) contributed to the account of each member of that category. The monthly basic pay is multiplied by 3 to give a quarterly figure. The total amount contributed per period to the deferred compensation trust fund is the sum of the amounts contributed to each of the four categories. An average annual amount is also calculated.

The Commission recommended giving separation pay to all personnel forced to separate (for nondisability reasons) who complete five or more years of service. The amount paid is equal to one-quarter of a month's basic pay for each year of service up to 10 years and one-half of a month's basic pay for each year of service from 11 to 30 years. One year's basic pay was suggested as the maximum sum to be paid.

In the model, forced separations (in the 6-30 year groups) are designated nonvoluntary attritions (NVATT). Nonvoluntary attritions occur in the model when personnel in each grade reach the high year of tenure for that grade or when members are forced out in a force draw-down circumstance.

Separation costs are formulated by the following equations:

$$A \quad SEPC.K(GD, J) = NVATT.K(GD, J) * IBPS(GD, J-5) * (J-5) * .25 \quad (C-19)$$

"J" indicates the 6 to 10 year-groups. Nonvoluntary attritions (NVATT) occur in this category when E-4's are forced out at the nine-year point.

$$A \quad NVATT.K(4, 8) = AGE.K(4, 9) \quad (C-20)$$

The number of E-4's who are forced to separate are the number of E-4's who fail to make promotion to E-5. In the model, these personnel are allowed to age (AGE) into the high year of tenure plus one year and are then attrited from the force.

Nonvoluntary attritions can also occur in the form of forced retirements under force drawdown scenarios. Formulation of force outs (FOUT)

is given below:

A $FOUT.K(F, YR)=0$
A $FOUT.K(GCR, YR)=RET.K(GCR, YR)-RET.K(GCR, YR)/RETM.K$ (C-21)
FOUT -- FORCE OUTS
RET -- RETIREMENTS
RETM -- RETIREMENT MANAGEMENT POLICY MULTIPLIER

It is assumed that management will deny reenlistment to personnel in the career force in order to meet decreased force authorizations. Management's force out actions are simulated using the multiplier FRETM which is discussed in Appendix B under retirement flows. In the model force outs occur only in grades E-7 to E-9. The number of force outs is determined by calculating the number of retirements which exceed the normal (expected) retirement rate.

The amount of separation pay for personnel in the 6 to 10 year-groups is $IBPS*.25*(J-5)$, one-quarter of a month's basic pay (IBPS) multiplied by the number of years of service completed (J-5).

Separation costs for personnel in the 11 to 30 year-groups are formulated below:

A $SEPC.K(GD, K)=NVATT.K(GD, K)*MIN(IBP(GD, K-10)*YOSN(GD)*.5,$ (C-22)
X $IBP(GD, K-10)*12)$

SEPC -- SEPARATION COST
NVATT -- NONVOLUNTEER ATTRITIONS
IBP -- QUARTERLY BASIC PAY AT START OF SIMULATION
YOSN -- YEARS OF SERVICE (USED FOR COMPUTATION)

Nonvoluntary attritions are accounted for at the high year of tenure for grades E-5 and E-7 by the same aging process used for grade E-4 above. Since the high year of tenure for E-6 (23 years) and E-8 (28 years) occurs in the middle of the 21 to 26 and 27 through 30 aggregate

year-groups, respectively, forced separations due to failure of promotion were ignored for these grades. (Programming convenience was the primary reason for this action.) An adjustment to the years-of-service used for computation (YOSN) also was necessary because of the aggregation in the 13 through 15 year-group categories. For each year-group category (11-15), the high year represented in that category was selected for use in computation (i.e., 11 years for year-group 11, 12 for year-group 12, 20 for year-group 13, 26 for year-group 14, and 30 for year-group 15). This was accomplished in one table equation:

$$T \quad YOSN=0/0/0/0/11/12/20/26/30 \quad (C-23)$$

YOSN -- YEARS OF SERVICE (USED FOR COMPUTATION)

Total separation costs are the sum of equations (C-20) and (C-21).

Total costs are formulated for each retirement scenario. Total costs are the sum of the total costs for the active force (RC + TRNC + TADP + STC) and the total retirement costs (which are different for the two systems). In either system, total cost for the active force (TOTCAF) is formulated by Equation (C-24).

$$A \quad TOTCAF.K=RC.K+TRNC.K+TADP.K+STC.K \quad (C-24)$$

TOTCAF -- TOTAL COST FOR THE ACTIVE FORCE

RC -- RECRUITING COSTS

TRNC -- TRAINING COSTS

TADP -- TOTAL ACTIVE DUTY PAY

STC -- SEPARATION TRAVEL COSTS

Total system cost (TOTSC) for the present system is computed as follows:

$$A \quad TOTSC.K=TOTCAF.K+TRP.K \quad (C-25)$$

TOTSC -- TOTAL SYSTEM COST

Under the Commission plan:

$$A \quad \text{TOTSC.K} = \text{TOTCAF.K} + \text{TRP.K} + \text{TCDCFT.K} + \text{TSEPC.K} \quad (\text{C-26})$$

TOTSC -- TOTAL SYSTEM COST
TOTCAF -- TOTAL COST FOR ACTIVE FORCE
TRP -- TOTAL RETIREMENT PAY
TCDCFT -- TOTAL COST FOR DEFERRED COMPENSATION TRUST FUND
TSEPC -- TOTAL SEPARATION COSTS

All costs for the active force are continuously discounted at a seven percent rate, and all retirement costs at a two percent rate.

The discounting equation for the present system is shown below:

$$A \quad \text{DTOTSC.K} = \text{TRP.K} / (\text{EXP}(.02 * .25 * \text{TIME.K})) + \text{TOTCAF.K} / (\text{EXP}(.07 * .25 * \text{TIME.K})) \quad (\text{C-27})$$

DTOTSC -- DISCOUNTED TOTAL SYSTEM COST
TRP -- TOTAL RETIREMENT PAY
TOTCAF -- TOTAL COST FOR THE ACTIVE FORCE
TIME -- ELAPSED TIME SINCE START OF SIMULATION

The time increment (TIME) represents the total elapsed time since the start of simulation.

Level equations are used to compute cumulative figures for each type of cost discussed in this section. The accumulations are used in evaluating the cost implications of the two retirement systems over specified periods of time.

In using the cost results, it must be remembered that they do not represent actual personnel costs, since major elements of the real system costs have been ignored. Only those costs which might be directly affected by a new retirement system were included.

APPENDIX D

Model Validation

APPENDIX D

Model Validation

The confidence users have in this particular model depends on how well it is accepted as a representation of the DOD enlisted personnel system and the decision making processes within that system. Confidence in the model comes from demonstration that the model can generate behavioral characteristics of the DOD enlisted personnel system in those areas relevant to the problems of alternative retirement programs. The model should show the direction and relative magnitude of major changes in system characteristics, such as promotion opportunity or grade levels, due to exogenous inputs or changes in policy.

This appendix describes the process by which the behavioral validity of the simulation was established. This process can be considered as three distinct steps: (1) determining that the conceptual model faithfully represents the structure of the system, (2) insuring that the computer program represents the conceptual model, and (3) establishing confidence that the model is sufficient for analyzing the problems for which it was intended. The design of the conceptual model was discussed in Chapters II through IV and Appendix B. The last two steps in the validation process are examined in this appendix through an equilibrium analysis and sensitivity testing conducted in several test cases.

The comparison of the conceptual and computer models can be facilitated by the establishment of model equilibrium. Although the system exhibits no behavior in an equilibrium state, it provides a base from which to examine system behavior caused by external disturbances or

policy changes. The establishment of equilibrium also serves as the first test of the internal logic of the model. Next, in order to examine the dynamic behavioral modes of the system, three test cases were developed to provide comparisons between the model and the actual system behavior. Two of the test cases involve disturbances from equilibrium due to internal changes in policy parameters while the third is based on an input external to the system.

Equilibrium

In Appendix B, the importance of equilibrium during the initial investigation of system behavior was discussed. From equilibrium, one can selectively disturb the system and observe the isolated system response. Once an understanding of the basic behavior of the system to the test inputs is achieved, the system can be disturbed under non-equilibrium conditions, and much of the behavior will be explained through the knowledge gained from equilibrium investigations.

Equilibrium in the DOD enlisted personnel system is a state in which all active duty grade-year categories remain constant over time, promotions are constant, and accessions are matched perfectly with constant force attrition (including retirements). The specific requirements for equilibrium in this study were:

- (1) The equilibrium accession rate is reasonably close to recent historic rates.
- (2) The equilibrium voluntary separation rates are reasonable close to recent historic rates.
- (3) Grade percentages reasonably agree with TOPCAP guidelines.

The equilibrium state initialized in the model was based on satisfying two requirements: (1) that the total size of the force be the

current (1977 data) total DOD enlisted force size and (2) that the grade-year profile correspond to the objective TOPCAP force profile (Ref 5:D-12). This was accomplished by determining the objective TOPCAP profile (by grade and year) as percentages and then applying these percentages to a force size equal to the current enlisted end strength. The effect was to increase the size of the objective TOPCAP force to DOD levels, while maintaining the TOPCAP grade-year profile.

This profile of the DOD enlisted force was then input to the model and a simulation was run to equilibrium. The objective was to let the simulation determine final equilibrium values, such as accessions, attritions, and promotions. This served the dual purpose as a check on the model structure, because if the model is capturing the key elements of the system correctly the system should be very close to its equilibrium profile. This was, in fact, the case as only very small adjustments were needed to the TOPCAP structure to put the system in equilibrium.

The complete list of initialization values for all levels (MEN) is contained in Appendix F with the model listing. The resulting equilibrium profile is illustrated in Figure D-1.

Test Cases

The attainment of equilibrium provides some assurance that the general formulation of the computer model is consistent with the structure of the conceptual model. However, in equilibrium there is no interaction of the variables, and much of the logic is not exercised during equilibrium simulation runs. In addition, sensitivity analysis is meaningless in equilibrium and there is no way to compare model

behavior to the real system while in equilibrium. Consequently, three test cases are presented which disturb the equilibrium system so that logic and interactions can be examined, sensitivity analysis performed, and behavioral comparisons made. The first test case is designed as a force ceiling disturbance. The desired enlisted force is decreased by 18,380 per quarter over a 5-year period. This represents approximately a 20 percent force drawdown. The second case is an exogenous disturbance to the attrition rates. Attritions are increased 20 percent beginning four quarters into the simulation and continue for the entire run. The third case is an exogenous disturbance to the enlistment rate. In this test case, enlistments are decreased by 20 percent for two years, beginning in the first quarter of the simulation. These test cases were chosen for two reasons. First, they were intended to illustrate very basic behavior of the system. Secondly, they were intended to provide a check of the model by simulating recent trends in the enlisted force.

The first runs of these test cases were made by entering each of the multipliers one at a time in order to isolate the effects of the multipliers from other policy and technical variable interactions. These runs also served to validate the formulation and behavior of the multipliers prior to the analysis of their simultaneous interaction in the test cases.

The test cases were run with parameters set at reasonable values. The parameters in the model fall into three broad categories: (1) time-to-adjust parameters (CFADT, FADT), (2) information delay and perception lag parameters, and (3) sensitivity of attrition response to promotion opportunity and military pay.

These runs were made to establish a degree of confidence in model

results. In various shakedown runs, those anomalous results that were found, were used as a basis for identifying improperly formulated management policies or variables.

After correcting improper formulations, a more detailed examination of the model behavior was made. The test cases were designed to investigate the similarity between the model and the system, especially in terms of problem symptoms. Confidence in the basic model behavior is based primarily on available descriptive knowledge of real system structure and behavior. However the test cases were also designed to approximate recent trends in the DOD enlisted force. The reader should refer to Table D-I for guidelines to the DYNAMO output interpretation.

It should be noted that in all of the test cases, all of the feedback loops are active.

Force Drawdown. The force drawdown represents a managed change in the end strength goals of the system. The desired strength is decreased by 367,600 over a 5 year period beginning at the end of the first year of simulation.

Figures C-3 through C-6 contain selected output from the force drawdown test case. It is assumed that there is feedback between attritions, and military pay and promotion opportunity. In addition, the adjustment time for force discrepancies is set at 8 quarters (two years).

Grades E-5 through E-9 reach desired levels within one year of the end of the requirements drawdown. The decline in the size of grades E-5 through E-9 is accomplished by two factors: (1) the decrease in promotion opportunity causes increased attrition in those grades, and (2) the career force discrepancy is large enough to initiate forced

TABLE D-I
Output Interpretation for Test Cases

Plot Symbol	Corresponding Model Variable	Definition
1,2,3,4, 5,6,7,8,9	GPROF (I)	Total personnel in each enlisted grade
T	TOTF	Total Actual Force Size
F	ACARF	Authorized Career Force
C	TCARF	Total Actual Career Force
R	TRET	Total Retirements (per qtr.)
A	TATT	Total Attritions (per qtr.)
P	TPR	Total Promotions (per qtr.)
E	ENLST	Enlistments (per qtr.)

NOTE: (1) Plot symbols should be identified with the proper scales, located at the top of each figure.

(2) Always check scales when comparing figures.

retirements in the year groups eligible for retirement (see Figure C-6). The number of personnel in grades E-1 through E-4 decline until the end of the force drawdown due to the decrease in enlistments (Figure C-6). In addition, the decrease in E-4's is due to a decrease in promotion opportunity to E-5, caused by the reduction in force size.

The long adjustment times required for both the lower grades and the total force to reach equilibrium (Figures C-4 and C-5) are accounted for by several factors. First, the large force discrepancy is being adjusted (in enlistments), over a two year period. That is, the force discrepancy component of enlistments adjusts for only one-eighth of the remaining discrepancy per quarter. This component is negative in sign. Second, the increase in attritions caused by

decreased promotion opportunity offsets part of the decrease in enlistments caused by the force discrepancy (see equation B-14). Finally the feedback loop from attritions to military pay has the effect of slowing attritions. The result of these interactions, is a slow oscillating return to equilibrium conditions. That is, the force adjustment parameters operate to slow the return to equilibrium. The parameters discussed above (force adjustment time, military pay multiplier, and promotion opportunity multiplier) are representative of explicit and implicit management policies that can be modified to address specific changes in internal objectives and external requirements. For instance, a shorter force adjustment time or increasing attritions could be instituted to adjust the force more quickly. It should be noted, however, that such a policy change would cause the system to exhibit a different behavior pattern with different management implications.

The relation between promotions and attritions is illustrated in Figure C-6. As promotions decline in response to the smaller force size, attritions increase (due to promotion opportunity). Promotions continue to decline until the force drawdown is complete. The promotion opportunity stays low until the E-4 grade profile is in equilibrium. This causes attritions to reach equilibrium much later than promotions, but at approximately the same time as promotion opportunity.

Figure C-4 also shows the management policy of forcing retirements once the career force discrepancy reaches a critical value. This discrepancy causes an increase in attritions until the force drawdown is complete. The system then adjusts to a level of retirements coinciding with the reduced force level.

Decreased Enlistments. In this test case the DOD's desired enlistments were decreased by 20 percent for two years. It was assumed that the feedback loops between attritions, and military pay and promotion opportunity were active. Also, the key force management goal is the total force objective. Figure C-7 shows the decrease in enlistments beginning in time period 1 and lasting for two years.

The effects on grade structure are shown in Figure C-8. Grade E-1 begins to decrease in period 2 as a result of the decrease in enlistments. As those who enlisted during the "depressed period" progress through the grades E-1 through E-4, those grades begin to decrease. This is caused by the below-normal level of enlistments during periods one through nine. The time of this decrease in grade size corresponds to the time-to-promote to that respective grade. For example, the phase shift between the curves for E-1's and E-4's in Figure C-8 is approximately 10-12 periods, which corresponds to the average time to promote to grade E-4.

The same type of time lag behavior is evident in Figure C-7. The second dip in attritions (between periods 12-14) corresponds to the time when the first group of "depressed period" enlistees reach grade E-4. Total attritions begin to decrease again because grade E-4 is still decreasing while grades E-1 to E-3 are well into their recovery. As enlistments return to normal and grade E-4 begins to receive the normal number of personnel feeding it again (period 19-20), attritions begin to increase. Notice that the overshoot of enlistments sets up a highly damped oscillation in grades E-1 to E-4. Grades E-5 through E-9 are not affected because grade E-4 is not decreased to the point where it could not feed grade E-5.

Figure C-10 illustrates the effects on the total force and career force. Total force decreases by an amount approximately equal to the decrease in enlistments over the two year period. The career force change is due entirely to the fluctuation in the number of E-4's, caused by the decrease in enlistments.

Increased Attrition. In this test case, the normal attrition rates were increased for all categories by 20 percent beginning in the fourth quarter. It was assumed that there were feedback loops between attritions and military pay and promotion opportunity. In addition, adjustments were made to total force management parameters. Figure C-11 shows the increase in attritions due to the increase in attrition rates. The number of attritions initially increases by 20 percent at period 4. This causes a total force discrepancy and immediate management response in the form of increased enlistments.

The effects on grade structure are shown in Figures C-12 and C-13. In Figure C-12, the increase in attritions causes an initial decrease in grades E-2 through E-4. As mentioned above, the increase in attritions causes a positive force discrepancy. This discrepancy plus the added attritions results in an increase in enlistments (see equation B-20). This increase in enlistments explains why the E-1 grade does not show a decrease initially. Grade E-1 increases in response to increased attritions causing a "hump" in the system. This "hump" is illustrated in Figure C-12 by the time-lagged humps in grades E-2 through E-4 corresponding to the year groups when enlistments were high.

The decrease in E-5's shown in Figure C-13 is the result of the change in the attrition pattern. The beginning force structure is

based upon historical attrition patterns. When this pattern changes and the total force goals remain constant, the system reacts by decreasing the career force size. That is, the force structure contained in the model is based on historical attrition rates. Changes in these rates will result in a change in the force structure as shown in Figure C-14. A more sensitive feedback loop between attritions and military pay would allow the system to readjust to meet E-5 goals.

In all of the test cases discussed in this section, the determination of enlistments was based on total force parameters and objectives. It was noted during shakedown runs, that when enlistments are determined using career force parameters (by equations B-14 and B-17) and a large disturbance is input to the system, the system exhibited a highly oscillatory behavior due to conflicting management policies inherent in the system.

GPROF(1)=1 GPRCF(2)=2 GPROF(3)=3 GPROF(4)=4

0.000T	50.000T	100.000T	150.000T	200.000T	1
0.000T	100.000T	200.000T	300.000T	400.000T	23
0.000T	200.000T	400.000T	600.000T	800.000T	4
0.0	- - - - -	- - - - -	- - - - -	- - - - -	1 - .
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
20.0	- - - - -	- - - - -	- - - - -	- - - - -	1 - .
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
40.0	- - - - -	- - - - -	- - - - -	- - - - -	1 - .
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
60.0	- - - - -	- - - - -	- - - - -	- - - - -	1 - .
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
.	.	.2 4 3	.	1	.
80.0	- - - - -	- - - - -	- - - - -	- - - - -	1 - .
.	.	.2 4 3	.	1	.

Figure D-1. Enlisted Force Equilibrium (Grades E1 - E4)

SLOTS(5)=5 GPROF(5)=+ SLOTS(6)=6 GPROF(6)=W SLOTS(7)=7
 GPROF(7)=X SLOTS(8)=8 GPROF(8)=Y SLOTS(9)=9 GPROF(9)=Z

0.000T	100.000T	200.000T	300.000T	400.000T	5+
0.000T	50.000T	100.000T	150.000T	200.000T	6W7X
0.000T	10.000T	20.000T	30.000T	40.000T	8Y
0.000T	5.000T	10.000T	15.000T	20.000T	9Z
0.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.	.	.	7	8	5 - 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
20.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.	.	.	7	8	5 - 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
40.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.	.	.	7	8	5 - 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
60.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.	.	.	7	8	5 - 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
.	.	.	7	8	5 6. 5+, 6W, 7X, 8Y9Z
80.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.	.	.	7	8	5 - 6. 5+, 6W, 7X, 8Y9Z

Figure D-2. Enlisted Force Equilibrium (Grades E5 - E9)

SLOTS(5)=5 GPROF(5)=+ SLOTS(6)=6 GPROF(6)=W SLOTS(7)=7
 GPROF(7)=X SLOTS(8)=8 GPROF(8)=Y SLOTS(9)=9 GPROF(9)=Z

300.000T	320.000T	340.000T	360.000T	380.000T	5+
140.000T	155.000T	170.000T	185.000T	200.000T	6W
90.000T	100.000T	110.000T	120.000T	130.000T	7X
28.000T	30.000T	32.000T	34.000T	36.000T	8Y
14.000T	15.000T	16.000T	17.000T	18.000T	9Z
0.0.	- - - - -	- - - - -	- - - - -	- - - - -	7 -685- . 5+,6W,7X,8Y9Z
.	.	.	.	.	7 685 . 5+,6W,7X,8Y9Z
.	.	.	.	.	7 685 . 5+,6W,7X,8Y9Z
.	.	.	.	.	7X 35W+ . 56,+Y,89,WZ
.	.	.	7.5 6+	.	+W,5X89,6YZ
.	.	.	75X+6.W	.	789,+Y7
.	.	5 7+ 6 W	.	.	+XY7,589
.	.	58 +7 X5 W	.	.	7Y,89,+Z
.	.	58+Y 7.X6 W	.	.	89,Y7
.	58 +Y 7 X6 W	.	.	.	89,Y7
20.0.	- - - - - 5 8+-Y- - 7 6 W -	- - - - -	- - - - -	- - - - -	6X,89,YZ
.	5 + Y 7 6 W	.	.	.	6X,+89,YZ
.5 8+ Y	7.6 W	.	.	.	6X,89,YZ
.5 8Z	7.6W	.	.	.	5+,7X,8Y9
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
40.0.	5-8- - - - - 7.6 - - - - -	- - - - -	- - - - -	- - - - -	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
60.0.	5-8- - - - - 7.6 - - - - -	- - - - -	- - - - -	- - - - -	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
.5 8	7.6	.	.	.	5+,6W,7X,8Y9Z
80.0.	5-8- - - - - 7.6 - - - - -	- - - - -	- - - - -	- - - - -	5+,6W,7X,8Y9Z

Figure D-3. Force Drawdown; Grade Distribution E-1 - E-4

GPROF (1)=1 GPROF (2)=2 GPROF (3)=3 GPROF (4)=4



Figure D-4. Force Drawdown; Grade Distribution E-5 - E-9

[illegible]

118

TRET=R TATT=A ENLST=E TPR=P



Figure D-6. Force Drawdown; Attritions, Enlistments, Promotions, and Retirements

TRET=R TATT=A ENLST=E TPR=P

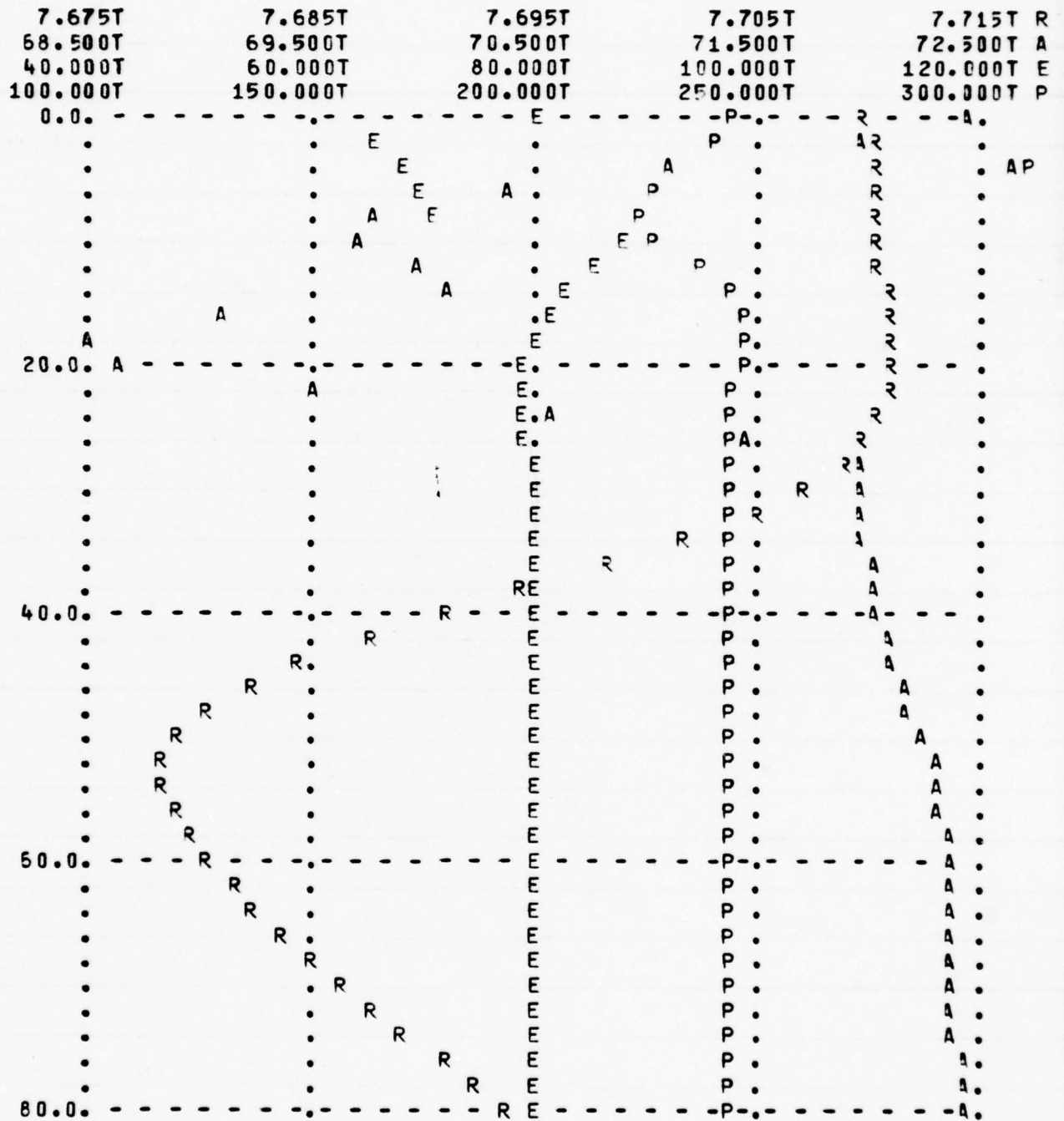


Figure D-7. Decreased Enlistments; Attritions, Enlistments, Promotions, and Retirements

GPROF(1)=1 GPROF(2)=2 GPROF(3)=3 GPROF(4)=4

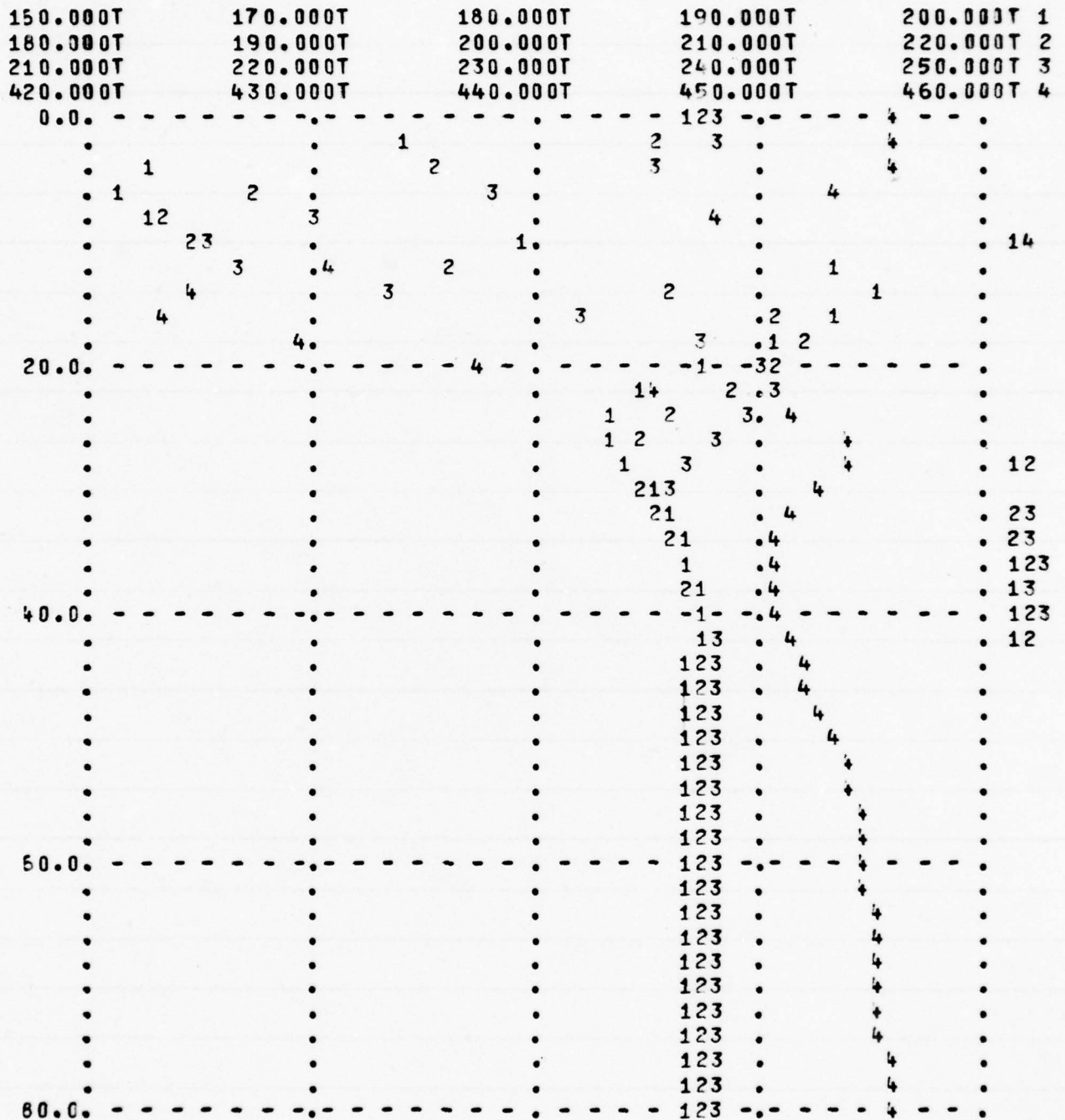


Figure D-8. Decreased Enlistments; Grade Distribution E-1 - E-4

SLOTS(5)=5 GPROF(5)=+ SLOTS(6)=6 GPROF(6)=W SLOTS(7)=7
 GPROF(7)=X SLOTS(8)=8 GPROF(8)=Y SLOTS(9)=9 GPROF(9)=Z

0.000T	100.000T	200.000T	300.000T	400.000T	5+
0.000T	50.000T	100.000T	150.000T	200.000T	6W7X
0.000T	10.000T	20.000T	30.000T	40.000T	8Y
0.000T	5.000T	10.000T	15.000T	20.000T	97
0.0.	-	-	-	-	-
.
.
.
.
.
.
.
.
.
20.0.	-	-	-	-	-
.
.
.
.
.
.
.
.
.
40.0.	-	-	-	-	-
.
.
.
.
.
.
.
.
.
60.0.	-	-	-	-	-
.
.
.
.
.
.
.
.
80.0.	-	-	-	-	-
.

Figure D-9. Decreased Enlistments; Grade Distribution E-5 - E-9

TOTF=T ACARF=F TCARF=C

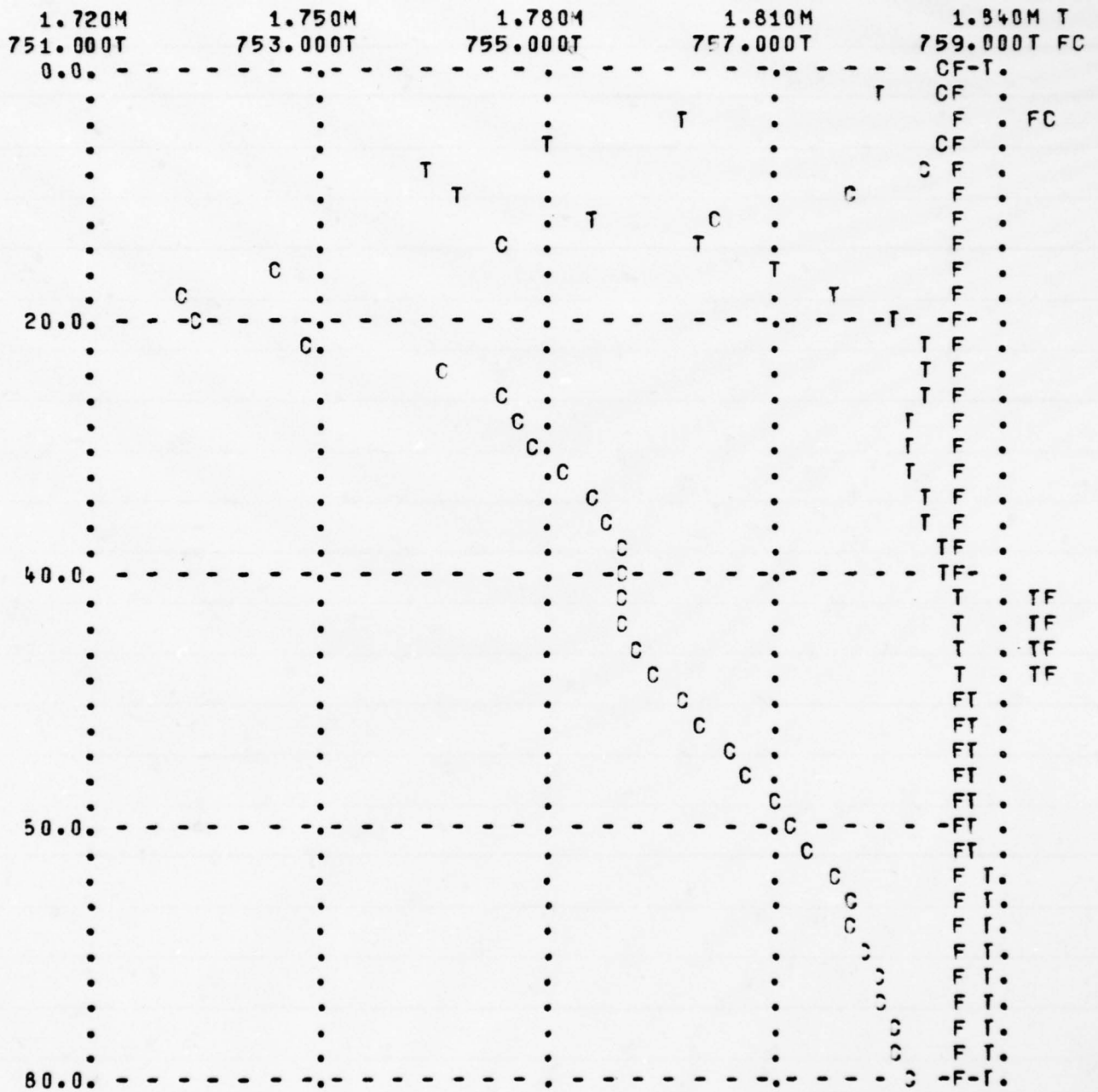


Figure D-10. Decreased Enlistments; Career and Total Force

TRET=R TATT=A ENLST=E TPR=P

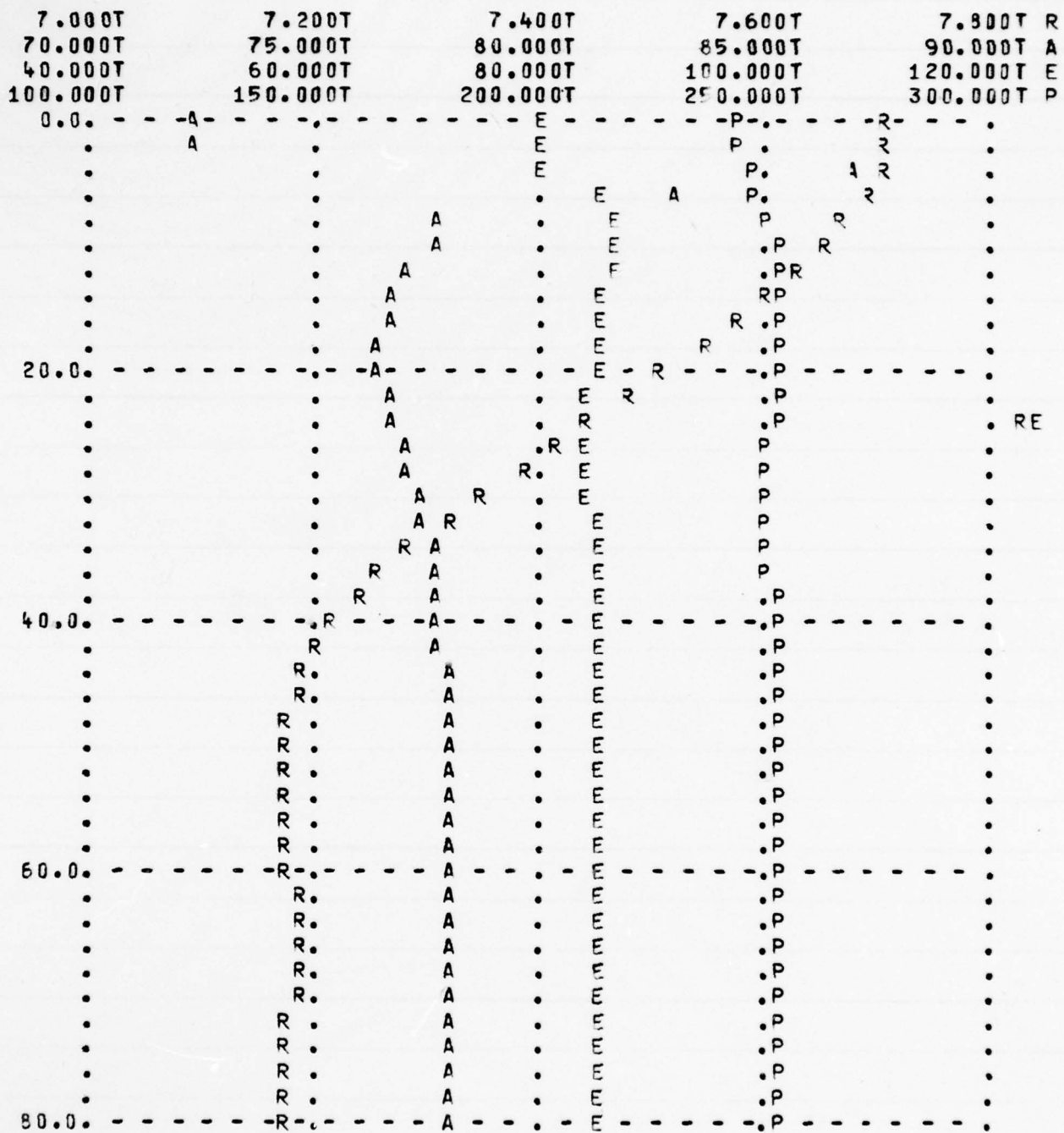


Figure D-11. Increased Attritions; Attritions, Enlistments, Promotions, and Retirements

185.000T	190.000T	195.000T	200.000T	205.000T	210.000T	215.000T	220.000T	225.000T	230.000T	235.000T	240.000T	245.000T	250.000T	255.000T	260.000T	265.000T	270.000T	275.000T	280.000T	285.000T	290.000T	295.000T	300.000T	305.000T	310.000T	315.000T	320.000T	325.000T	330.000T	335.000T	340.000T	345.000T	350.000T	355.000T	360.000T	365.000T	370.000T	375.000T	380.000T	385.000T	390.000T	395.000T	400.000T	405.000T	410.000T	415.000T	420.000T	425.000T	430.000T	435.000T	440.000T	445.000T	450.000T	455.000T	460.000T	465.000T	470.000T	475.000T	480.000T	485.000T	490.000T	495.000T	500.000T	505.000T	510.000T	515.000T	520.000T	525.000T	530.000T	535.000T	540.000T	545.000T	550.000T	555.000T	560.000T	565.000T	570.000T	575.000T	580.000T	585.000T	590.000T	595.000T	600.000T	605.000T	610.000T	615.000T	620.000T	625.000T	630.000T	635.000T	640.000T	645.000T	650.000T	655.000T	660.000T	665.000T	670.000T	675.000T	680.000T	685.000T	690.000T	695.000T	700.000T	705.000T	710.000T	715.000T	720.000T	725.000T	730.000T	735.000T	740.000T	745.000T	750.000T	755.000T	760.000T	765.000T	770.000T	775.000T	780.000T	785.000T	790.000T	795.000T	800.000T	805.000T	810.000T	815.000T	820.000T	825.000T	830.000T	835.000T	840.000T	845.000T	850.000T	855.000T	860.000T	865.000T	870.000T	875.000T	880.000T	885.000T	890.000T	895.000T	900.000T	905.000T	910.000T	915.000T	920.000T	925.000T	930.000T	935.000T	940.000T	945.000T	950.000T	955.000T	960.000T	965.000T	970.000T	975.000T	980.000T	985.000T	990.000T	995.000T	1000.000T
0.0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100																																																															
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100																																																															
2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20																																																																																																																																															

125

SLOTS(5)=5 GPROF(5)=+ SLOTS(6)=6 GPROF(6)=W SLOTS(7)=7
 GPROF(7)=X SLOTS(8)=8 GPROF(8)=Y SLOTS(9)=9 GPROF(9)=Z

375.600T 0.000T 0.000T 0.000T 0.0.	375.900T 50.000T 10.000T 5.000T	376.200T 100.000T 20.000T 10.000T	376.500T 150.000T 30.000T 15.000T	376.800T 5+ 200.000T 6W7X 40.000T 8Y 20.000T 9Z
0.0.	- - - - -	- - - - -	- 7 - - -	+ 5 - 8 - - - 6. 6W,7X,8Y9Z
.	.	.	7	5 8 5. 5+,6W,7X,8Y9Z
.	.	.	7	5 8 5. 5+,6W,7X,8Y9Z
.	.	.	7	5 8 5. 5+,6W,7X,8Y9Z
.	.	.	7	5 8 5. 5+,6W,7X,8Y9Z
.	.	.	7	5 8 5. 5+,6W,7X,8Y9Z
.	.	.	7	5 8 5. 5+,6W,7X,8Y9Z
.	.	.	7	5 8 5. 5+,6W,7X,8Y9Z
.	.	.	7	5 8 5. 5+,6W,7X,8Y9Z
20.0.	- - - - -	- - - - -	- 7 - - -	- 5 - 8 - - - 5. 5+,6W,7X,8Y9Z
.	.	.	7	5 8 5. 5+,6W,7X,8Y9Z
.	.	.	7	5 8 6. 6W,7X,8Y9Z
.	.	+	7	5 8 5. 6W,7X,8Y9Z
.	.	.	7	5 8 5. 6W,7X,8Y9Z
.	.	.	7	5 8 5. 6W,7X,8Y9Z
.	.	.	7	5 8 5. 6W,7X,8Y9Z
.	.	.	7	5 8 5. 6W,7X,8Y9Z
.	.	.	7	5 8 5. 6W,7X,8Y9Z
.	.	.	7	5 8 5. 6W,7X,8Y9Z
40.0.	- - - - -	- - - - -	- 7 - - -	- 5 - 8 - - - 5. 6W,7X,8Y9Z
.	+	.	7	5 8 6. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
60.0.	- - - - -	- - - - -	- 7 - - -	- 5 - 8 - - - 6. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
.	+	.	7	5 8 5. 6W,7X,8Y9Z
80.0.	- - - - -	- - - - -	- 7 - - -	- 5 - 8 - - - 5. 6W,7X,8Y9Z

Figure D-13. Increased Attritions; Grade Distribution E-5 - E-9

TOTF=T ACARF=F TCARF=C

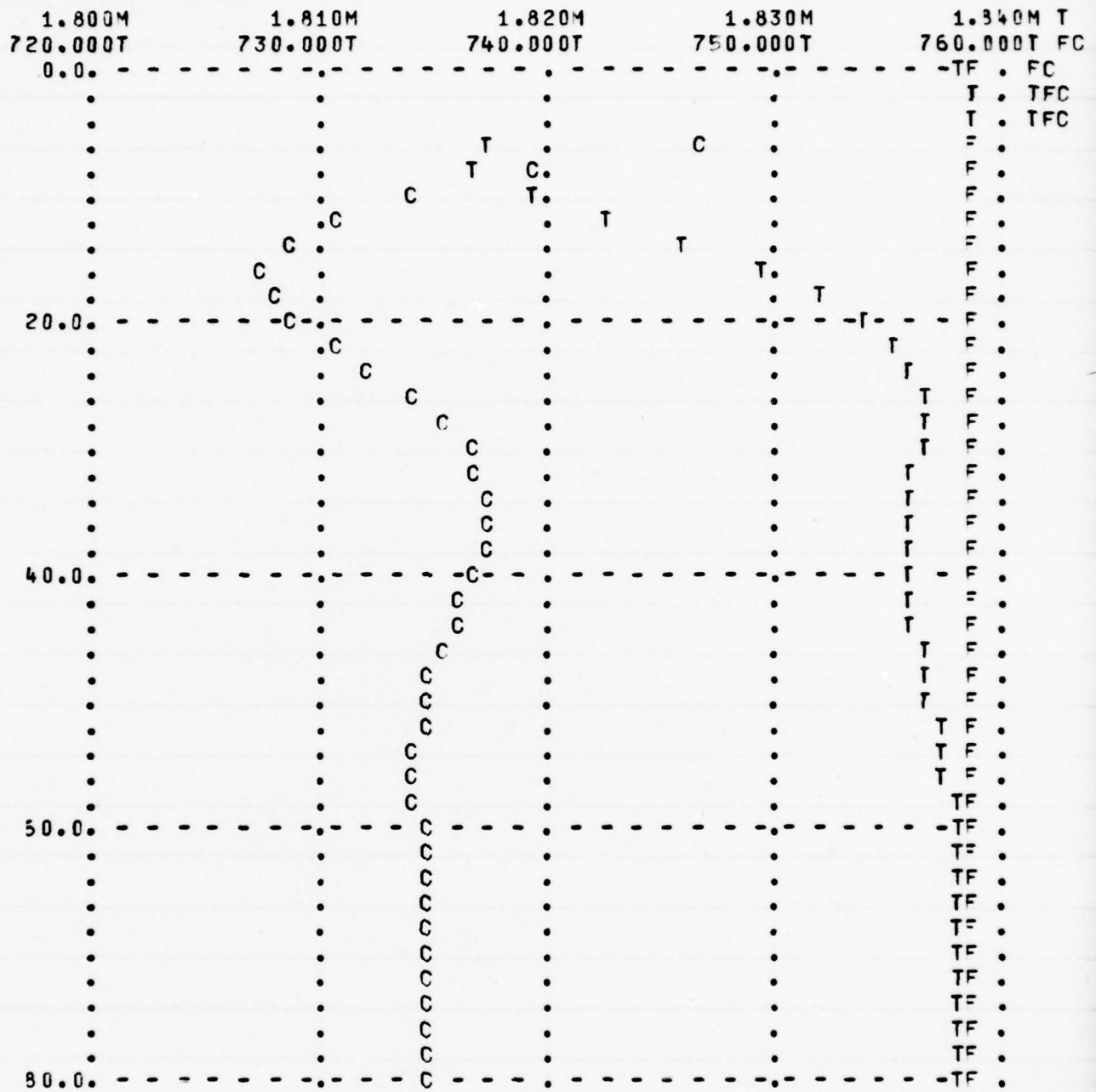


Figure D-14. Increased Attritions; Career and Total Force

APPENDIX E

Analysis Output

APPENDIX E

Analysis Output

This appendix contains the plotted DYNAMO output which was summarized in Chapter V. The order in which the output appears here parallels the case presentation shown in Table V. Explanation of the plot symbols (except those for the cost plots) is found in Table D-I. The cost explanations are given below:

- R - Total Retirement Pay
- T - Total System Cost
- A - Total Cost for the Active Force

GPROF (1)=1 GPROF (2)=2 GPROF (3)=3 GPROF (4)=4

0.000T	50.000T	100.000T	150.000T	200.000T	1
0.000T	100.000T	200.000T	300.000T	400.000T	23
0.000T	200.000T	400.000T	600.000T	800.000T	4
0.0.	- - - - -	.2- 4 3	- - - - -	1 - .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
20.0	- - - - -	.2- 4 3	- - - - -	1 - .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
40.0	- - - - -	.2- 4 3	- - - - -	1 - .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
60.0	- - - - -	.2- 4 3	- - - - -	1 - .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
.	.	.2 4 3	.	1 .	.
80.0	- - - - -	.2- 4 3	- - - - -	1 - .	.

Figure E-1. Enlisted Force Equilibrium (Grades E1 - E4) under the Present System and the Commission System With No Change in Attrition Rates

SLOTS(5)=5 GPROF(5)=+ SLOTS(6)=6 GPROF(6)=W SLOTS(7)=7
 GPROF(7)=X SLOTS(8)=8 GPROF(8)=Y SLOTS(9)=9 GPROF(9)=Z

0.000T	100.000T	200.000T	300.000T	400.000T	5+
0.000T	50.000T	100.000T	150.000T	200.000T	6W7X
0.000T	10.000T	20.000T	30.000T	40.000T	8Y
0.000T	5.000T	10.000T	15.000T	20.000T	9Z
0.0.	-	-	-	-	-
.
.
.
.
.
.
.
.
.
20.0.	-	-	-	-	-
.
.
.
.
.
.
.
.
.
.
40.0.	-	-	-	-	-
.
.
.
.
.
.
.
.
.
.
60.0.	-	-	-	-	-
.
.
.
.
.
.
.
.
.
80.0.	-	-	-	-	-
.
.
.
.
.
.
.
.
.

Figure E-2. Enlisted Force Equilibrium (Grades E5 - E9) under the Present System and the Commission System With No Change in Attrition Rates

TRET=R TATT=A ENLST=E TPR=P

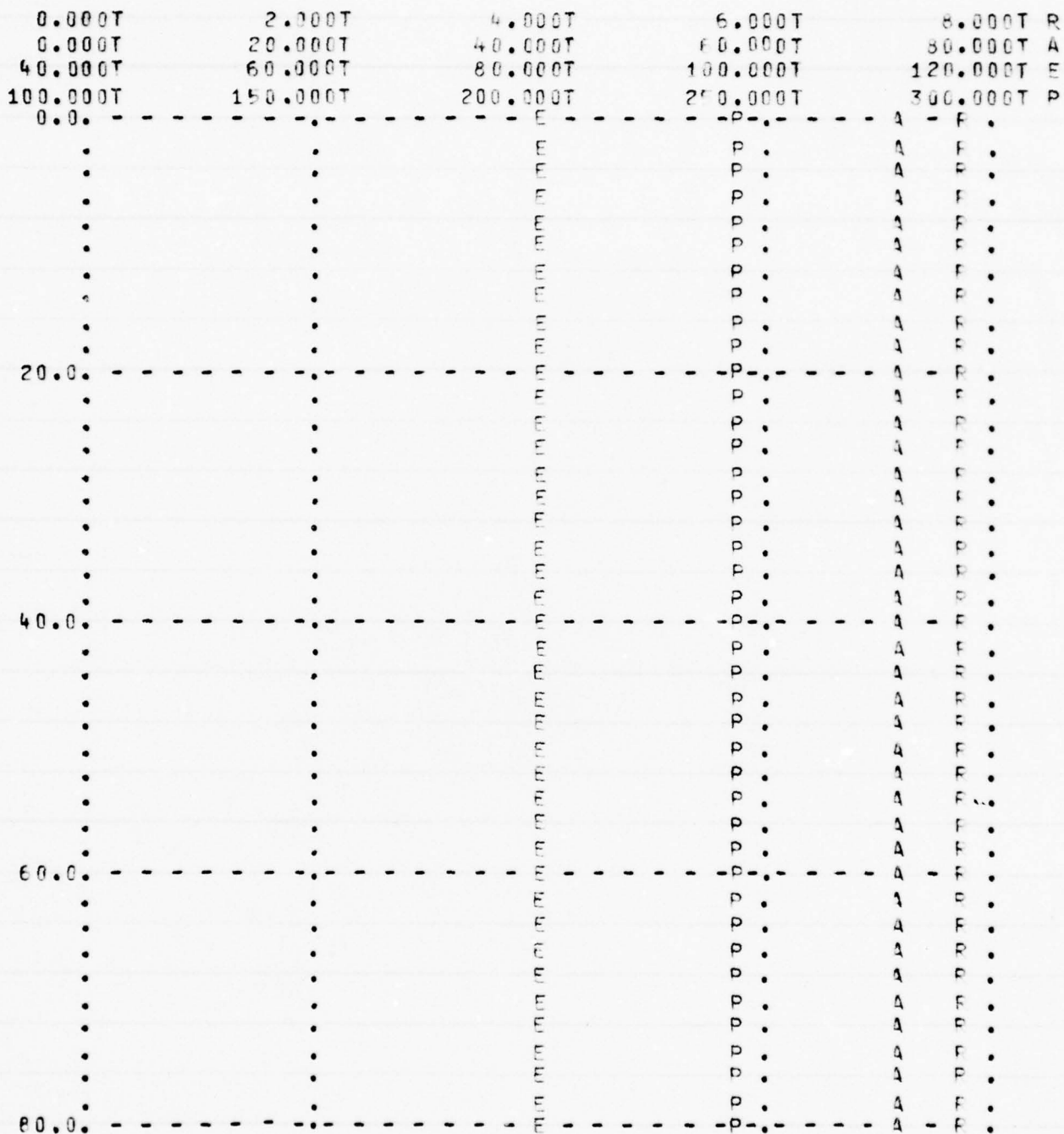


Figure E-3. Equilibrium Enlistments, Promotions, Attritions, and Retirements Under the Present System and the Commission System With No Change in Attrition Rates

TOTF=T ACARF=F TCARF=C

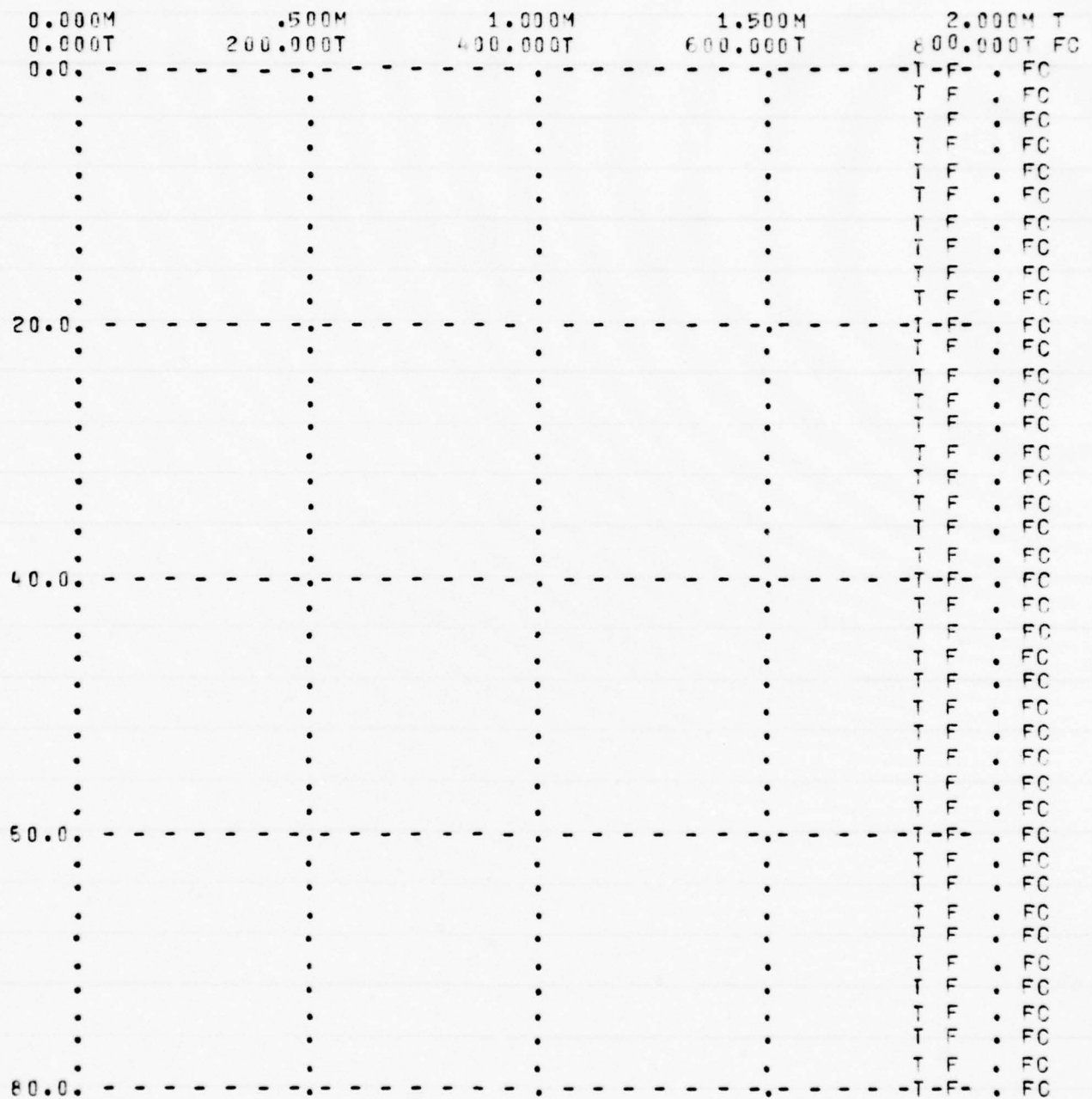


Figure E-4. Equilibrium Total Force and Career Force Under the Present System and the Commission System With No Change in Attrition Rates

TRP=R TOTSC=T TCTCAF=A

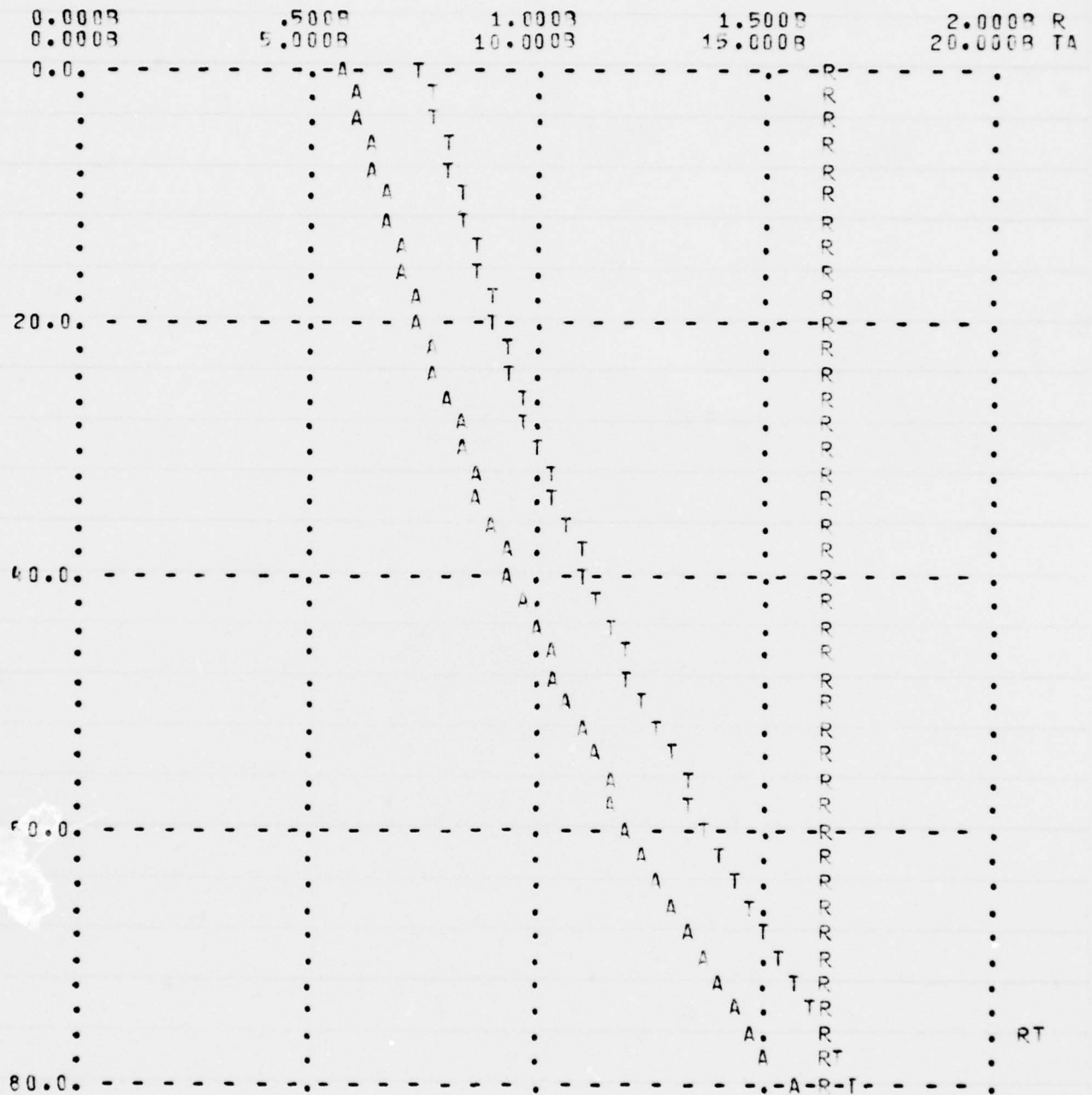


Figure E-5. Costs Under the Present System in Equilibrium

TRP=R TOTSC=T TOTCAF=A

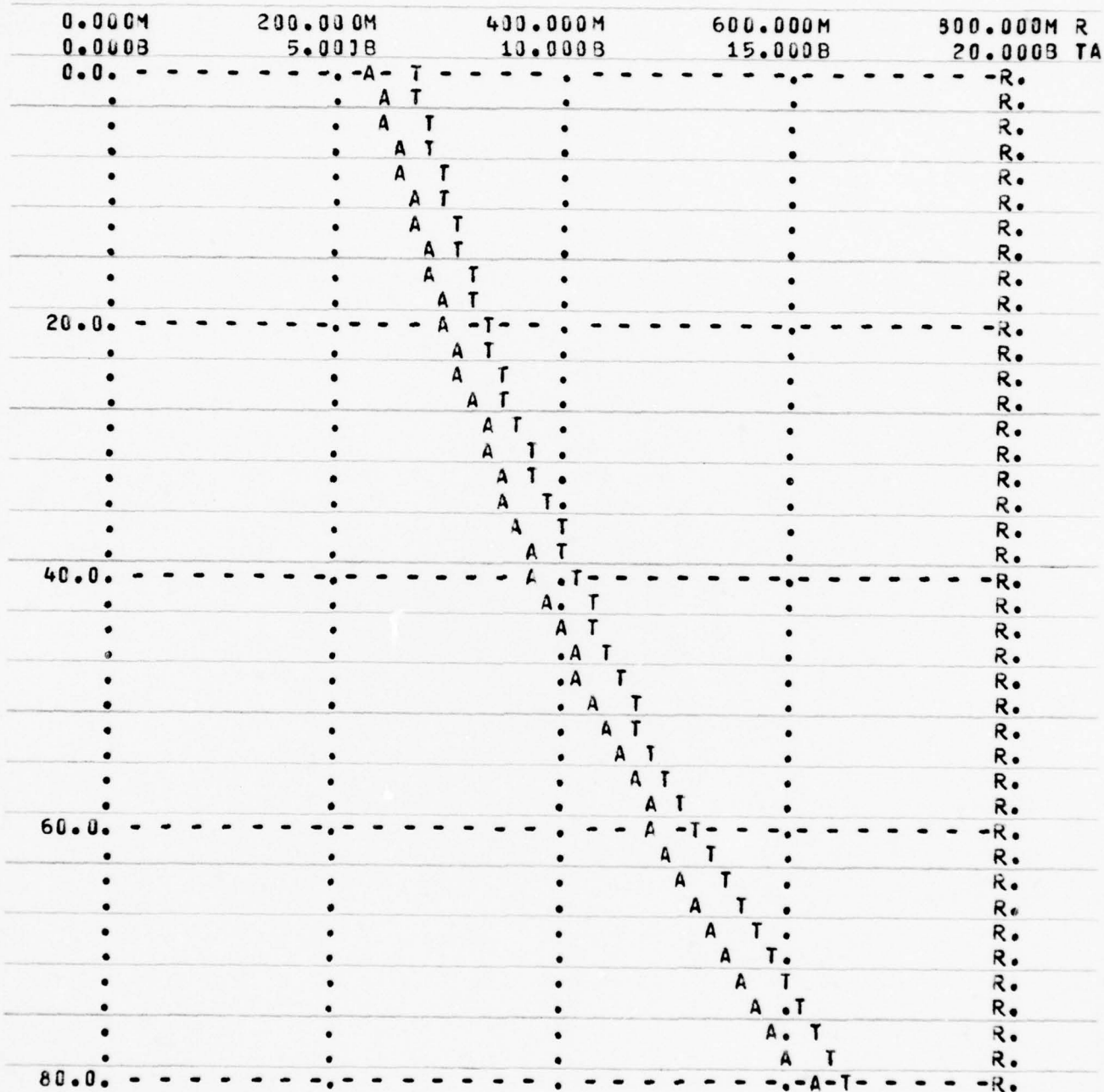


Figure E-6. Costs Under the Commission System in Equilibrium With No Change in Attrition Rates

186.600T	186.800T	187.000T	187.200T	187.400T	187.600T
207.250T	207.350T	207.450T	207.550T	207.650T	207.750T
238.250T	238.350T	238.450T	238.550T	238.650T	238.750T
456.000T	456.500T	457.000T	457.500T	458.000T	458.500T
0.0	32-4	-1			
20.0	-2	-2	-3	4	
40.0	4	-2	3		
60.0		2	3		
80.0	4	2	3		

136

SLOTS(5)=5 GPROF(5)=+ SLOTS(6)=6 GPROF(6)=W SLOTS(7)=7
 GPROF(7)=X SLOTS(8)=8 GPROF(8)=Y SLOTS(9)=9 GPROF(9)=Z

0.000T	100.000T	200.000T	300.000T	400.000T	5+
0.000T	50.000T	100.000T	150.000T	200.000T	6W7X
0.000T	10.000T	20.000T	30.000T	40.000T	8Y
0.000T	5.000T	10.000T	15.000T	20.000T	9Z
0.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.	5 -5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 6. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
20.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.	5 -5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
40.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.	5 -5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
60.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.	5 -5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
80.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.	5 -5. 5+,6W,7X,8Y9Z

Figure E-8. Grades E5 to E9 Under Low Intended System Response

SLOTS(5)=5 GPROF(5)=+ SLOTS(6)=6 GPROF(6)=W SLOTS(7)=7
 GPROF(7)=X SLOTS(8)=8 GPROF(8)=Y SLOTS(9)=9 GPROF(9)=Z

0.000T	100.000T	200.000T	300.000T	400.000T	5+
0.000T	50.000T	100.000T	150.000T	200.000T	6W7X
0.000T	10.000T	20.000T	30.000T	40.000T	8Y
0.000T	5.000T	10.000T	15.000T	20.000T	9Z
0.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.
.
.
.
.
.
.
.
.
20.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.
.
.
.
.
.
.
.
.
.
40.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.
.
.
.
.
.
.
.
.
.
60.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.
.
.
.
.
.
.
.
.
.
80.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -

Figure E-8. Grades E5 to E9 Under Low Intended System Response

TRET=R TATT=A ENLST=E TPR=P

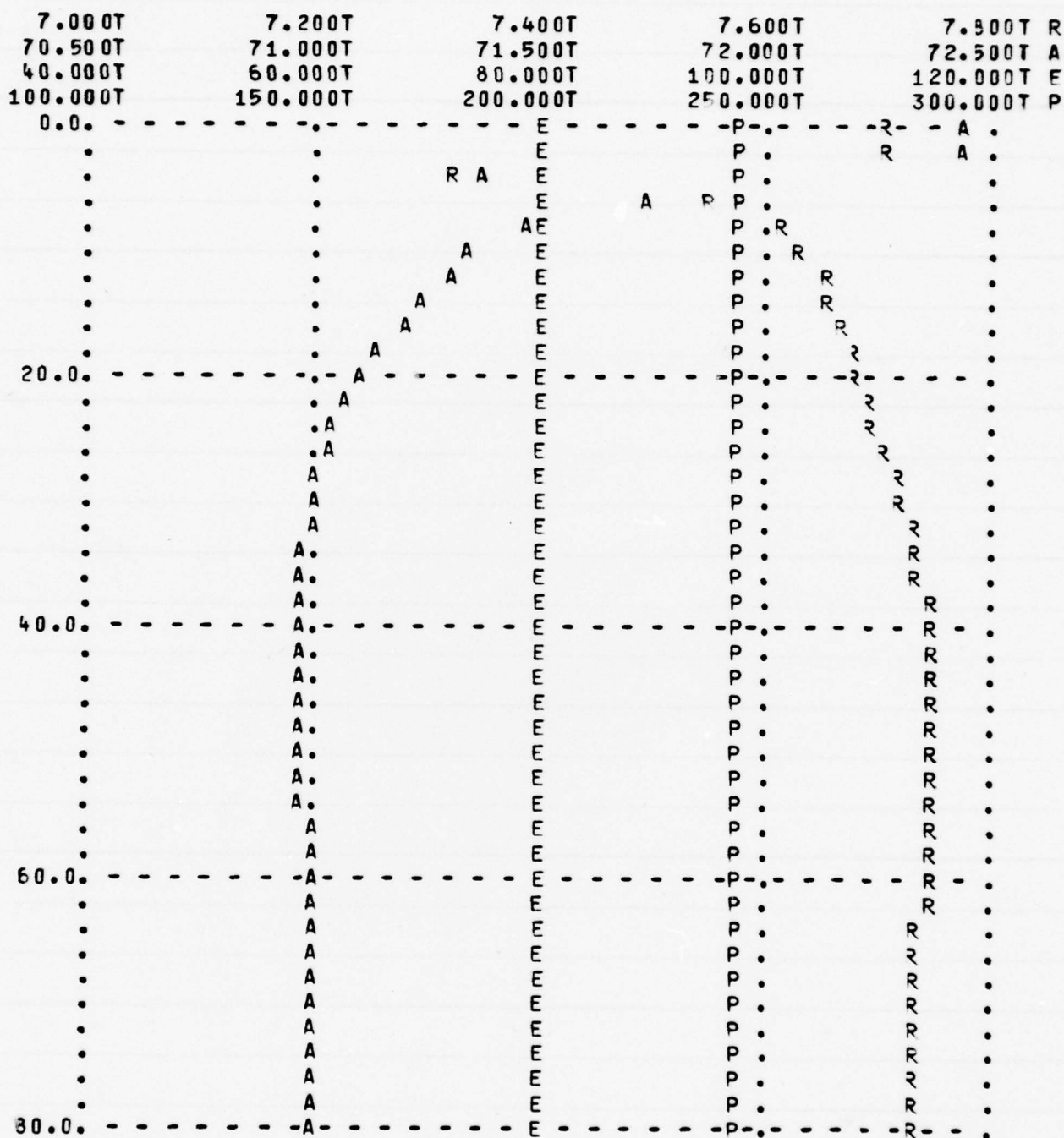


Figure E-9. Total Enlistments, Promotions, Attritions, and Retirements Under Low Intended System Response

TOTF=T ACARF=F TCARF=C

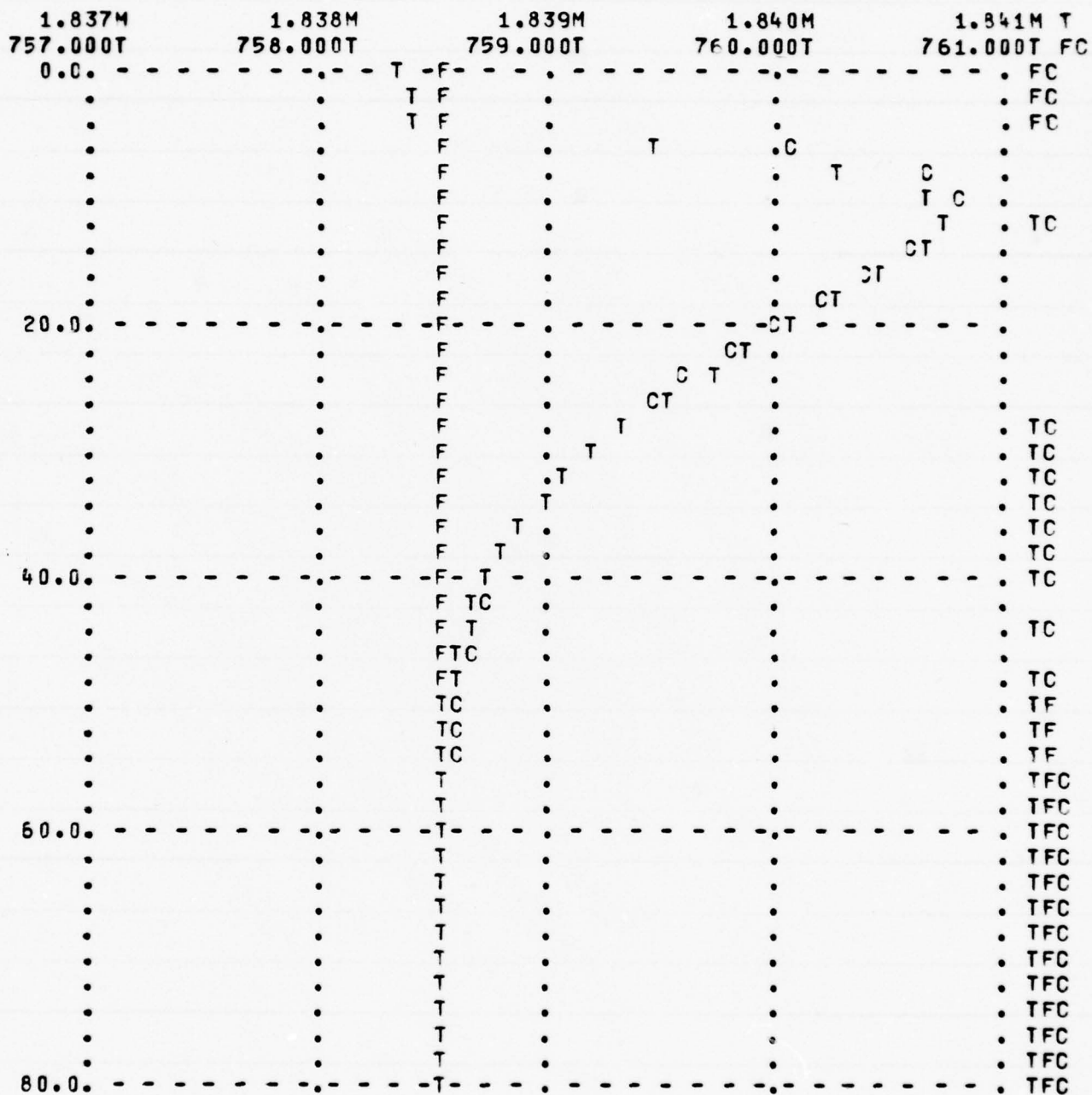


Figure E-10. Total Force and Career Force Under Low Intended System Response

[illegible]

140

GPROF(1)=1 GPROF(2)=2 GPROF(3)=3 GPROF(4)=4



Figure E-12. Grades E1 to E4 Under Moderate Intended System Response

SLOTS(5)=5 GPROF(5)=+ SLOTS(6)=6 GPROF(6)=W SLOTS(7)=7
 GPROF(7)=X SLOTS(8)=8 GPROF(8)=Y SLOTS(9)=9 GPROF(9)=Z

0.000T	100.000T	200.000T	300.000T	400.000T	5+
0.000T	50.000T	100.000T	150.000T	200.000T	6W7X
0.000T	10.000T	20.000T	30.000T	40.000T	8Y
0.000T	5.000T	10.000T	15.000T	20.000T	9Y
0.0.	- - - - -	- - - - -	- - - - -	- - - - -	- 8- 5 -5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 6. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
20.0.	- - - - -	- - - - -	- - - - -	- - - - -	- 8- 5 -5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
40.0.	- - - - -	- - - - -	- - - - -	- - - - -	- 8- 5 -5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
60.0.	- - - - -	- - - - -	- - - - -	- - - - -	- 8- 5 -5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
.	8 5 5. 5+,6W,7X,8Y9Z
80.0.	- - - - -	- - - - -	- - - - -	- - - - -	- 8- 5 -5. 5+,6W,7X,8Y9Z

Figure E-13. Grades E5 to E9 Under Moderate Intended System Response

TRET=R TATT=A ENLST=E TPR=P

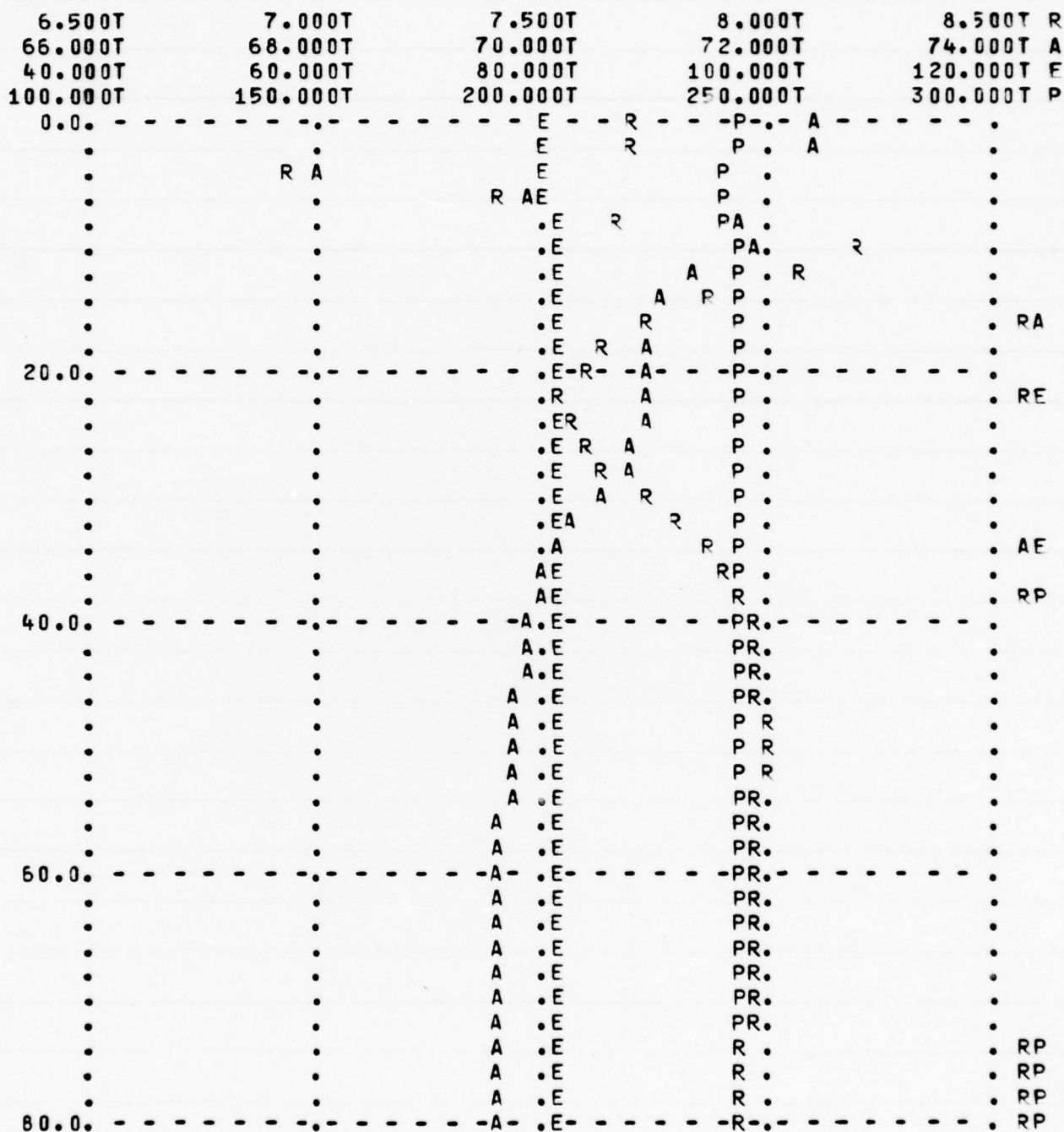


Figure E-14. Total Enlistments, Promotions, Attritions, and Retirements Under Moderate Intended System Response

TOTF=T ACARF=F TCARF=C

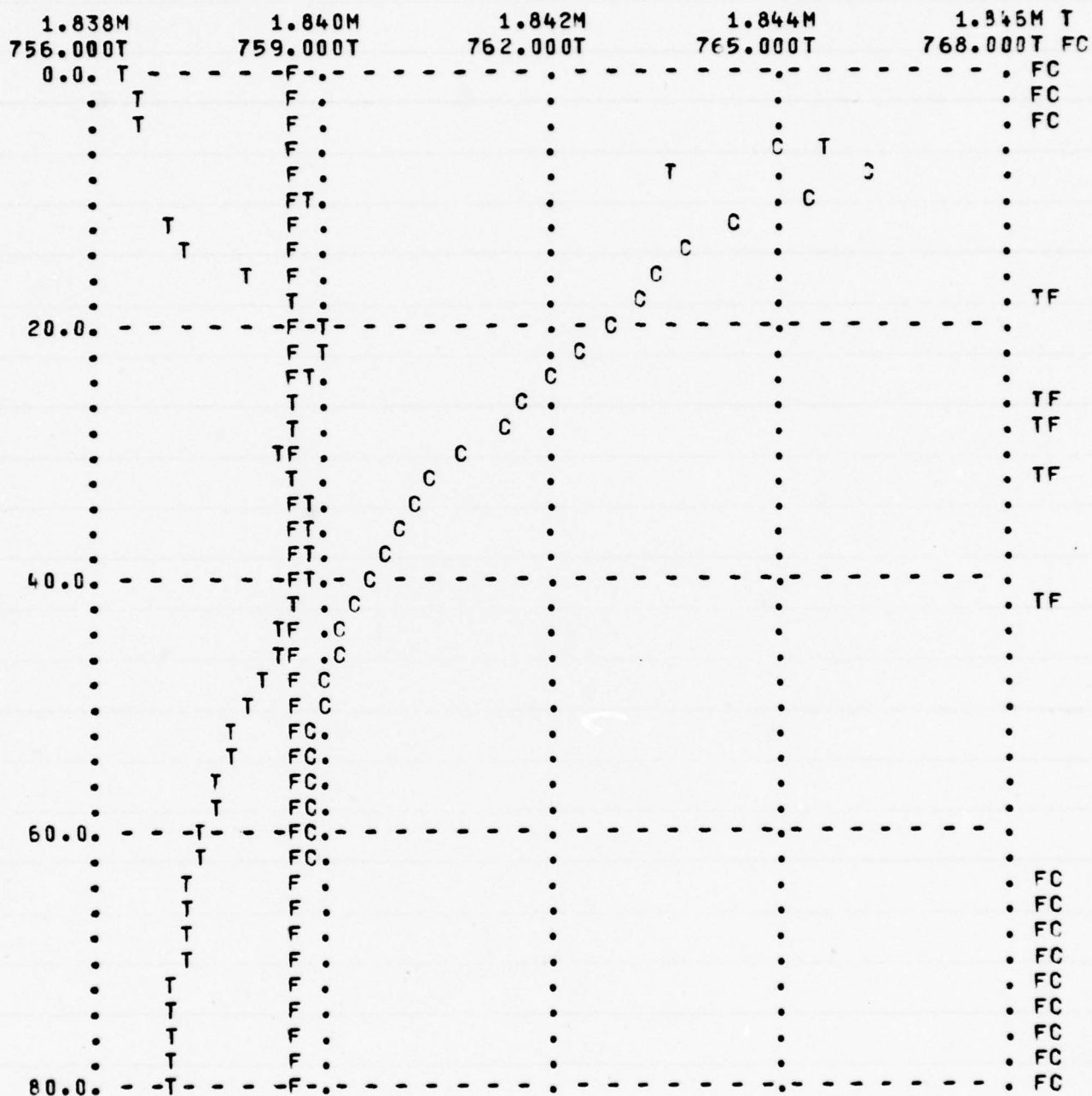


Figure E-15. Total Force and Career Force Under Moderate Intended System Response

TRP=R TOTSC=T TOTCAF=A

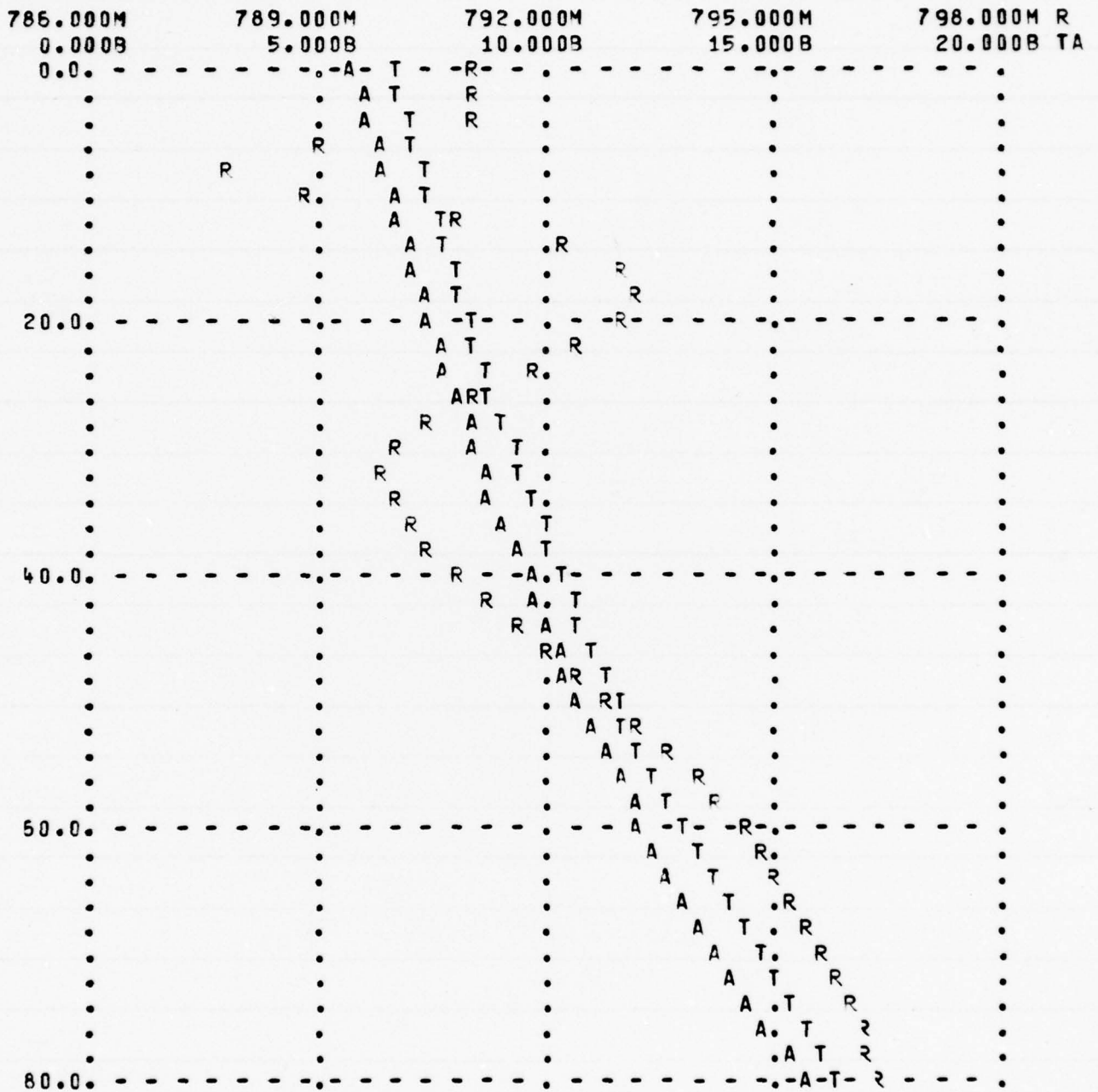


Figure E-16. Costs Under Moderate Intended System Response

[illegible]

146

SLOTS(5)=5 GPROF(5)=+ SLOTS(6)=6 GPROF(6)=W SLOTS(7)=7
 GPROF(7)=X SLOTS(8)=8 GPROF(8)=Y SLOTS(9)=9 GPROF(9)=Z

0.000T	100.000T	200.000T	300.000T	400.000T	5+
0.000T	50.000T	100.000T	150.000T	200.000T	6W7X
0.000T	10.000T	20.000T	30.000T	40.000T	8Y
0.000T	5.000T	10.000T	15.000T	20.000T	9Z
0.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.
.
.
.
.
.
.
.
.
20.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.
.
.
.
.
.
.
.
.
.
40.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.
.
.
.
.
.
.
.
.
.
60.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.
.
.
.
.
.
.
.
.
.
80.0.	- - - - -	- - - - -	- - - - -	- - - - -	- - - - -
.

Figure E-18. Grades E5 to E9 Under High Intended System Response

6.000T	7.000T	8.000T	9.000T	10.000T R
55.000T	67.000T	69.000T	71.000T	73.000T A
40.000T	60.000T	80.000T	100.000T	120.000T E
100.000T	150.000T	200.000T	250.000T	300.000T P
0.0.	- - - - -	R - E - - - -	P - - - - -	A - .
.	.	R E	P .	A .
. A	. R.	.E	P .	. .
.	.	.E	AP .	. .
.	. R	.E	A .	. AP
.	.	.E R	PR	. .
.	.	.E R A	P .	. RE
.	.	RE A	P .	. .
.	.	R.E A	P .	. .
20.0.	- - - - -	R-E-A- - - -	P- - - - -	. .
.	.	.E A	P .	. .
.	. R	.E A	P .	. .
.	. R R	.E A	P .	. .
.	. R R	.E A	P .	. .
.	. R R	.E A	P .	. .
.	. R R	.E A	P .	. .
.	. R	.E A	P .	. .
.	.	R.E A	P .	. .
40.0.	- - - - -	RE- - - - -	P- - - - -	. RA
.	.	AR	P .	. RE
.	.	AR	P .	. RE
.	.	AR	P .	. RE
.	.	AER	P .	. .
.	.	AER	P .	. .
.	.	AER	P .	. .
.	.	AER	P .	. .
.	.	AR	P .	. RE
.	.	AR	P .	. RE
60.0.	- - - - -	AR- - - - -	P- - - - -	. RE
.	.	AR	P .	. RE
.	.	AR	P .	. RE
.	.	AR	P .	. RE
.	.	AR	P .	. RE
.	.	AR	P .	. RE
.	.	AR	P .	. RE
.	.	AR	P .	. RE
80.0.	- - - - -	A.R- - - - -	P- - - - -	. RE

148

TOTF=T ACARF=F TCARF=C

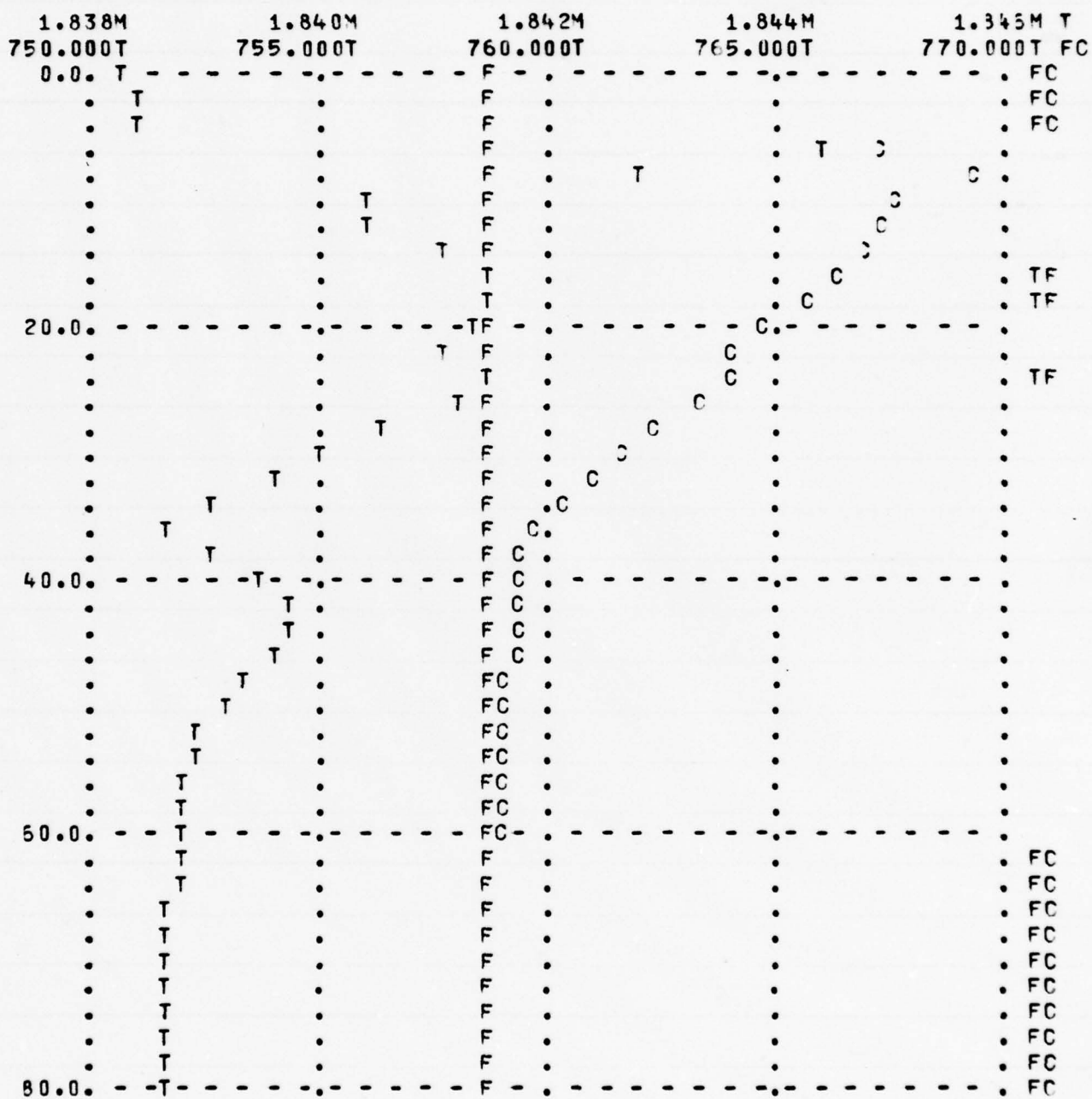


Figure E-20. Total Force and Career Force Under High Intended System Response

TRP=R TOTSC=T TOTCAF=A

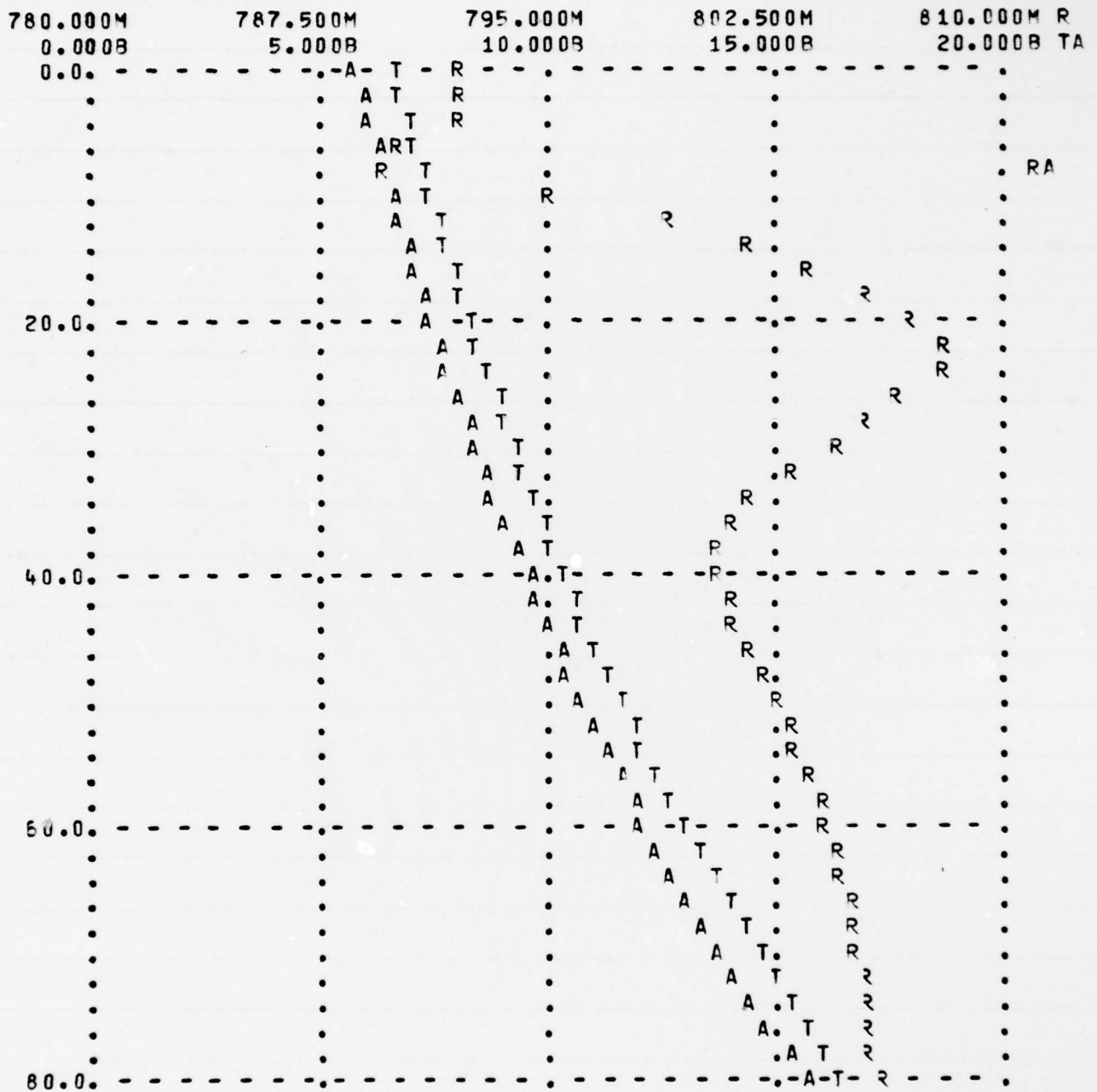


Figure E-21. Costs Under High Intended System Response

APPENDIX F

Computer Program Listing

APPENDIX F

Computer Program Listing

```
ATTACH, DYNAMO, DYNJCL1, ID=T780341, CY=2.  
MAP, PART.  
BEGIN, DYNAMO, DYNAMO, CM=230000, V=450.  
*EOR  
* DOD ENLISTED FORCE MODEL --  
NOTE  
NOTE * * * FORCE STRUCTURE LEVELS * * *  
NOTE  
C   TOP=9/OLD=15  
C   TOPL=8/OLDL=14  
FOR GD=1, TOP  
FOR YR=1, OLD  
FOR GDL=1, TOPL  
FOR YRL=1, OLDL  
FOR GDU=2, TOP  
FOR YRU=2, OLD  
FOR PRU=5, TOPL  
FOR X=1, 3  
FOR Y=4, 6  
FOR Z=7, 9  
FOR FDU=2, 4  
FOR SDU=6, OLD  
FOR YRC=5, OLD  
FOR GFT=2, 4  
FOR GCR=5, 9  
FOR FY=1, 16  
FOR A=1, 7  
FOR B=1, 3  
FOR C=5, 9  
FOR D=9, 12  
FOR F=1, 4  
FOR G=13, 15  
FOR H=8, 9  
FOR I=1, 5  
FOR J=6, 10  
FOR K=11, 15  
FOR L=1, 10  
FOR M=5, 12  
FOR N=14, 15  
FOR S=2, OLDL  
FOR R=1, 13  
FOR Q=1, 2
```

```

L  MEN.K(GD, YR)=MEN.J(GD, YR)+DT*(GAINS.JK(GD, YR)
X    -LOSSES.JK(GD, YR))
N  MEN(GD, YR)=MENI(GD, YR)
T  MENI(*, 1)=160240/148190/36479/0/0/0/0/0/0
T  MENI(*, 2)=26699/59080/167790/93458/0/0/0/0/0
T  MENI(*, 3)=0/0/33995/195420/0/0/0/0/0
T  MENI(*, 4)=0/0/0/114440/43980/0/0/0/0
T  MENI(*, 5)=0/0/0/40863/56512/0/0/0/0
T  MENI(*, 6)=0/0/0/10519/61665/2057/0/0/0
T  MENI(*, 7)=0/0/0/1472/56990/4607/0/0/0
T  MENI(*, 8)=0/0/0/0/46028/7869/0/0/0
T  MENI(*, 9)=0/0/0/0/35945/11269/86/0/0
T  MENI(*, 10)=0/0/0/0/27854/14692/276/0/0
T  MENI(*, 11)=0/0/0/0/21053/18116/690/0/0
T  MENI(*, 12)=0/0/0/0/15019/21019/1448/2/0
T  MENI(*, 13)=0/0/0/0/11309/112640/104890/24710/1987
T  MENI(*, 14)=0/0/0/0/255/3142/16391/8968/10708
T  MENI(*, 15)=0/0/0/0/0/0/561/1849/5070
NOTE *****
NOTE *****
NOTE ***** GAIN RATES *****
NOTE *****
NOTE *****
R  GAINS.KL(1, 1)=ENLST.K
R  GAINS.KL(1, FDU)=AGE.K(1, FDU)
R  GAINS.KL(1, YRC)=0
R  GAINS.KL(GDU, 1)=PR.K(GDU, 1)
R  GAINS.KL(GDU, FDU)=PR.K(GDU, FDU)+AGE.K(GDU, FDU)
R  GAINS.KL(GDU, 5)=MAX(REUP.K(GDU), 0)+PR.K(GDU, 5)
R  GAINS.KL(GDU, SDU)=PR.K(GDU, SDU)+AGE.K(GDU, SDU)
A  REUP.K(TOP)=MAX(MIN(REEN.K, AGE.K(9, 5)), 0)
A  REUP.K(GDL)=MAX(MIN(REEN.K-SUMV(REUP.K(*), GDL+1, TOP),
X    AGE.K(GDL, 5)), 0)
NOTE *****
NOTE *****
NOTE ***** LOSS RATES *****
NOTE *****
NOTE *****
R  LOSSES.KL(TOP, OLD)=ATT.K(TOP, OLD)+RET.K(TOP, 2)
R  LOSSES.KL(TOP, 14)=ATT.K(TOP, 14)+RET.K(TOP, 1)+AGE.K(TOP, 15)
R  LOSSES.KL(GDL, R)=ATT.K(GDL, R)+
X    +PR.K(GDL+1, R)+AGE.K(GDL, R+1)
R  LOSSES.KL(GDL, OLD)=ATT.K(GDL, OLD)+RET.K(GDL, 2)
X    +PR.K(GDL+1, OLD)
R  LOSSES.KL(GDL, 14)=ATT.K(GDL, 14)+RET.K(GDL, 1)+PR.K(GDL+1, 14)
R  LOSSES.KL(TOP, R)=ATT.K(TOP, R)+AGE.K(TOP, R+1)

```

NOTE * * * * *

NOTE

NOTE

ACCESSION SECTION

NOTE

NOTE * * * * *

A FDSC.K=FORCE.K-SUM(MEN.K)
A FORCE.K=1838500+TEST1.K
A ACARF.K=FM.K*FORCE.K
A FM.K=FMC+TEST7.K
C FMC=.41259
A TEST7.K=0
A CARF.K(GD)=SUMV(MEN.K(GD,*),5,OLD)
A TCARF.K=SUM(CARF.K)
A CATT.K(GD)=SUMV(ATT.K(GD,*),5,OLD)
A TCAT.K=SUM(CATT.K)
A CRET.K(GD)=SUMV(RET.K(GD,*),1,2)
A TCRET.K=SUM(CRET.K)
A REEN.K=MAX(CFDSC.K/CFADT+SMOOTH(TCAT.K,AST)
X +SMOOTH(TCRET.K,AST),0)
A CFDSC.K=ACARF.K-TCARF.K
A ENLST.K=MIN(SUPPLY.K,DEMAND.K)
A DEMAND.K=CLIP(DNORM.K,DFDD.K,FOD,0)
A DNORM.K=MAX(REEN.K/CONR.K,0)*ENLSTM.K
A DFDD.K=MAX(FDSC.K/FADT+SMOOTH(SUM(ATT.K),AST)+
X SMOOTH(SUM(RET.K),AST)+SUM(FOA5.K),0)
C FOD=1
A ENLSTM.K=TABHL(TEM,SMOOTH(TOTF.K/FORCE.K,4),.8,1.2,.1)
T TEM=1/1/1/1/1
A EFYA.K=SHIFTL(PIP.K,1)
L PIP.K(1)=PIP.J(1)+DT*ENLST.J
N PIP(FY)=PIPI(FY)
T PIPI=0/80145/80145/80145/80145/80145/80145/
X 80145/80145/80145/80145/80145/80145/80145/
A CONR.K=SUMV(AGE.K(*,5),1,TOP)/SMOOTH(EFYA.K,4)
N ENLST=80145
A SUPPLY.K=SUPA.K+SUPB.K
A SUPA.K=HSG.K*NRN*UM.K*WM.K*.25
A SUPB.K=(POP.K-HSG.K)*.25
A HSGE.K=MIN(SUPA.K,DEMAND.K)
A NHSGE.K=MAX(DEMAND.K-HSGE.K,0)
A PNHSE.K=NHSGE.K/ENLST.K
A POP.K=TABHL(POPT,TIME.K,0,LENGTH,20)
T POPT=8.7E6/8.6E6/7.9E6/7.3E6/7.9E6/8.2E6/8.6E6/8.2E6/
X /8.2E6/8.2E6/8.2E6/8.2E6/8.2E6/8.2E6/8.2E6/
X 8.2E6/8.2E6/8.2E6/8.2E6/8.2E6


```

NOTE * * * * *
NOTE
NOTE
NOTE
NOTE * * * * *
C   NRN=.041
N   SUPA=150000
A   HSG.K=TABHL(HSGT, TIME.K, 0, LENGTH, 20)
T   HSGT=6.3E6/6.3E6/5.5E6/5.8E6/6.2E6/6.5E6/6.6E6/6.5E6
X   /6.5E6/6.5E6/6.5E6/6.5E6/6.5E6/6.5E6/6.5E6/6.5E6/
X   6.5E6/6.5E6/6.5E6/6.5E6/6.5E6
A   UM.K=TABHL(UMT, UR.K, 3, 18, 3)
T   UMT=1/1/1/1/1/1
A   UR.K=6*TEST6.K
A   TEST6.K=1
A   WM.K=TABHL(TMP, SMOOTH(IMW.K/CWI.K, 8), .5, 2.0, .25)
T   TMP=1/1/1/1/1/1/1
C   AST=8/CFADT=4/FADT=4
NOTE * * * * *
NOTE
NOTE
NOTE
NOTE * * * * *
A   AGE.K(GD, 1)=0
A   AGE.K(GD, OLD)=MAX((MEN.K(GD, 14)-ATT.K(GD, 14)-RET.K(GD, 14))/
X   GPTIME(14), 0)
A   AGE.K(GD, S)=MAX((MEN.K(GD, S-1)-ATT.K(GD, S-1))/GPTIME(S-1), 0)
T   GPTIME=4/4/4/4/4/4/4/4/4/4/4/4/32/24/16
NOTE * * * * *
NOTE
NOTE
NOTE
NOTE
NOTE * * * * *
A   PRC.K(1, YR)=0
A   PRC.K(GFT, YR)=SMENTP.K(GFT)*PALLOC(GFT, YR)/AVTP(GFT, YR)
A   PRC.K(GCR, YR)=MAX(PALLOC(GCR, YR)*DPR.K(GCR), 0)
A   MENTP.K(1, YR)=0
A   MENTP.K(GDU, YR)=MAX(MEN.K(GDU-1, YR)-ATT.K(GDU-1, YR), 0)
X   *PET(GDU, YR)
A   SMENTP.K(1)=0
A   SMENTP.K(GDU)=SUMV(MENTP.K(GDU, *), 1, OLD)
T   AVTP(*, 1)=0/3/3/1
T   AVTP(*, 2)=0/1/1/1
T   AVTP(*, 3)=0/1/1/3
T   AVTP(*, 4)=0/1/1/1
T   AVTP(*, 5)=0/1/1/1
T   AVTP(*, 6)=0/1/1/1
T   AVTP(*, 7)=0/1/1/1
T   AVTP(*, 8)=0/1/1/1
T   AVTP(*, 9)=0/1/1/1
T   AVTP(*, 10)=0/1/1/1
T   AVTP(*, 11)=0/1/1/1
T   AVTP(*, 12)=0/1/1/1
T   AVTP(*, 13)=0/1/1/1
T   AVTP(*, 14)=0/1/1/1
T   AVTP(*, 15)=0/1/1/1
A   PRI.K(GD, YR)=CLIP(PRC.K(GD, YR), MENTP.K(GD, YR), MENTP.K(GD, YR)
X   , PRC.K(GD, YR))

```

```

A   PRTG.K(GD)=SUMV(PRI.K(GD,*),1,OLD)
A   PRDSC.K(1)=0
A   PRDSC.K(GFT)=0
A   PRDSC.K(GCR)=DPR.K(GCR)-PRTG.KK(GCR)
A   PRF.K(GCR,OLD)=MAX(MIN(PRDSC.K(GCR),MENTP.K(GCR,OLD)-PRI.K(GCR,OLD)
X     *PET2(GCR,OLD),0)
A   PRF.K(GCR,YRL)=MAX(MIN(PRDSC.K(GCR)-SUMV(PRF.K(GCR,*),YRL+1,OLD)
X     ,MENTP.K(GCR,YRL)-PRI.K(GCR,YRL))*PET2(GCR,YRL),0)
A   PRF.K(1,YR)=0
A   PRF.K(GFT,YR)=0
A   PR.K(GD,YR)=CLIP(PRI.K(GD,YR)+PRF.K(GD,YR),IPR(GD,YR),TIME.K,1)

```

```

T   PET(*,1)=0/1/1/0/0/0/0/0/0
T   PET(*,2)=0/1/1/1/0/0/0/0/0
T   PET(*,3)=0/1/1/1/0/0/0/0/0
T   PET(*,4)=0/1/1/1/1/0/0/0/0
T   PET(*,5)=0/0/0/1/1/0/0/0/0
T   PET(*,6)=0/0/0/1/1/1/0/0/0
T   PET(*,7)=0/0/0/1/1/1/0/0/0
T   PET(*,8)=0/0/0/0/1/1/0/0/0
T   PET(*,9)=0/0/0/0/1/1/1/0/0
T   PET(*,10)=0/0/0/0/1/1/1/0/0
T   PET(*,11)=0/0/0/0/1/1/1/0/0
T   PET(*,12)=0/0/0/0/1/1/1/1/0
T   PET(*,13)=0/0/0/0/1/1/1/1/1
T   PET(*,14)=0/0/0/0/0/1/1/1/1
T   PET(*,15)=0/0/0/0/0/0/0/1/1
T   PET2(*,1)=1/1/1/1/1/1/1/1/1
T   PET2(*,2)=0/0/1/1/1/1/1/1/1
T   PET2(*,3)=0/0/0/1/1/1/1/1/1
T   PET2(*,4)=0/0/0/0/1/1/1/1/1
T   PET2(*,5)=0/0/0/0/0/1/1/1/1
T   PET2(*,6)=0/0/0/0/0/1/1/1/1
T   PET2(*,7)=0/0/0/0/0/1/1/1/1
T   PET2(*,8)=0/0/0/0/0/1/1/1/1
T   PET2(*,9)=0/0/0/0/0/1/1/1/1
T   PET2(*,10)=0/0/0/0/0/1/1/1/1
T   PET2(*,11)=0/0/0/0/0/0/1/1/1
T   PET2(*,12)=0/0/0/0/0/0/1/1/1
T   PET2(*,13)=0/0/0/0/0/0/1/1/1
T   PET2(*,14)=0/0/0/0/0/0/0/0/1
T   PET2(*,15)=0/0/0/0/0/0/0/0/0
A   DPR.K(F)=0
A   DPR.K(TOP)=SLOTS.K(TOP)-SUMV(MEN.K(TOP,*),1,OLD)+
X     SUMV(ATT.K(TOP,*),1,OLD)+SUMV(RET.K(TOP,*),1,2)
A   DPR.K(PRU)=SLOTS.K(PRU)-SUMV(MEN.K(PRU,*),1,OLD)+
X     SUMV(ATT.K(PRU,*),1,OLD)+SUMV(RET.K(PRU,*),1,2)+
X     SUMV(PRI.K(PRU+1,*),1,OLD)
A   SLOTS.K(GD)=FORCE.K*GDPROF.K(GD)

```

```

T  PALLOC(*,1)=0/.80/.15/0/0/0/0/0/0
T  PALLOC(*,2)=0/.19/.75/.133/0/0/0/0/0
T  PALLOC(*,3)=0/.007/.07/.557/0/0/0/0/0
T  PALLOC(*,4)=0/.003/.03/.310/.49/0/0/0/0
T  PALLOC(*,5)=0/0/0/0/0/.30/0/0/0/0
T  PALLOC(*,6)=0/0/0/0/0/.15/.053/0/0/0
T  PALLOC(*,7)=0/0/0/0/0/.06/.075/0/0/0
T  PALLOC(*,8)=0/0/0/0/0/.097/0/0/0
T  PALLOC(*,9)=0/0/0/0/0/.115/.005/0/0
T  PALLOC(*,10)=0/0/0/0/0/.126/.011/0/0
T  PALLOC(*,11)=0/0/0/0/0/.126/.024/0/0
T  PALLOC(*,12)=0/0/0/0/0/.115/.044/.0003/0
T  PALLOC(*,13)=0/0/0/0/0/.293/.863/.4827/.071
T  PALLOC(*,14)=0/0/0/0/0/0/.053/.517/.885
T  PALLOC(*,15)=0/0/0/0/0/0/0/0/.044
A  GDPROF.K(GD)=INPROF(GD)+TEST2.K(GD)
T  INPROF=0/0/0/0/0/.204852/.106288/.0676367/
X  .0193255/.00966279
NOTE *****
NOTE
NOTE                                     ATTRITION FLOWS
NOTE *****
A  ATT.K(GD,YR)=MAX(MEN.K(GD,YR)*ATTMP.K(GD)*ATTM.K(GD,YR)
X    *ATTMP.K(GD)*ATTRB.K(YR)*.25*ATTN.K(GD,YR),0)
A  FOA5.K(1)=AGE.K(1,5)
A  FOA5.K(GDU)=MAX(AGE.K(GDU,5)-REUP.K(GDU),0)
A  VATT.K(GD,YR)=ATT.K(GD,YR)+RET.K(GD,YR)
A  ATTN.K(GD,YRC)=MIN(4.0,ATTC(GD,YRC)*TEST3.K(GD,YRC))
A  ATTN.K(GD,F)=MIN(4.0,FTATTP(F)*TEST3.K(GD,F))
T  FTATTP=.131/.142/.170/.359
T  ATTC(*,1)=0/0/0/0/0/0/0/0/0/0
T  ATTC(*,2)=0/0/0/0/0/0/0/0/0/0
T  ATTC(*,3)=0/0/0/0/0/0/0/0/0/0
T  ATTC(*,4)=0/0/0/0/0/0/0/0/0/0
T  ATTC(*,5)=4.0/4.0/4.0/.79/.402/.096/0/0/0
T  ATTC(*,6)=4.0/4.0/4.0/.168/.093/.071/0/0/0
T  ATTC(*,7)=4.0/4.0/4.0/.177/.141/.139/0/0/0
T  ATTC(*,8)=4.0/4.0/4.0/.344/.151/.092/0/0/0
T  ATTC(*,9)=4.0/4.0/4.0/4.0/.142/.125/0/0/0
T  ATTC(*,10)=4.0/4.0/4.0/4.0/.085/.110/0/0/0
T  ATTC(*,11)=4.0/4.0/4.0/1.0/.067/.071/0/0/0
T  ATTC(*,12)=4.0/4.0/4.0/4.0/.077/.051/0/0/0
T  ATTC(*,13)=4.0/4.0/4.0/4.0/.049/.037/0/0/0
T  ATTC(*,14)=0/0/0/0/0/0/0/0/0/0
T  ATTC(*,15)=0/0/0/0/0/0/0/0/0/0

```

```

A  ATTRB.K(F)=1
A  ATTRB.K(M)=1+STEP(HT1,ST1)
A  ATTRB.K(13)=1+STEP(HT2,ST2)
A  ATTRB.K(N)=1+STEP(HT3,ST3)
C  HT1=0/HT2=0/HT3=0
C  ST1=0/ST2=0/ST3=0
C  SLRB=0
C  SRBI=1
C  SRBD=1
A  ATTMP.K(X)=TABHL(TMP1,SMOOTH(IMW.K/CWI.K,8),.5,2.0,.25)
A  ATTMP.K(Y)=TABHL(TMP2,SMOOTH(IMW.K/CWI.K,8),.5,2.0,.25)
A  ATTMP.K(Z)=TABHL(TMP3,SMOOTH(IMW.K/CWI.K,8),.5,2.0,.25)
T  TMP1=1/1/1/1/1/1/1/1
T  TMP2=1/1/1/1/1/1/1/1
T  TMP3=1/1/1/1/1/1/1/1
A  ATTM.K(X,YR)=TABHL(TAM,SMOOTH(TCARF.K/ACARF.K,4),.92,1.08,.04)
A  ATTM.K(Y,YR)=1
A  ATTM.K(Z,YR)=1
T  TAM=1/1/1/1/1/1
A  ATP.K(X)=1
A  ATP.K(4)=CLIP(TABHL(TPO5,SMOOTH(P.K(5)*4/SMENTP.K(5),4),
X    .66,.84,.03),1.0,TIME.K,4)
A  ATP.K(5)=CLIP(TABHL(TPO6,SMOOTH(P.K(6)*4/SMENTP.K(6),4),
X    .12,.18,.01),1.0,TIME.K,4)
A  ATP.K(6)=CLIP(TABHL(TPO7,SMOOTH(P.K(7)*4/SMENTP.K(7),4),
X    .08,.11,.005),1.0,TIME.K,4)
A  ATP.K(7)=CLIP(TABHL(TPO8,SMOOTH(P.K(8)*4/SMENTP.K(8),4),
X    .04,.07,.005),1.0,TIME.K,4)
A  ATP.K(8)=CLIP(TABHL(TPO9,SMOOTH(P.K(9)*4/SMENTP.K(9),4),
X    .0835,.1135,.005),1.0,TIME.K,4)
A  ATP.K(9)=1
C  EPRT5=27931
C  EPRT6=10221
C  EPRT7=4313
C  EPRT8=1723
C  EPRT9=875
T  TPO5=1/1/1/1/1/1/1/1
T  TPO6=1/1/1/1/1/1/1/1
T  TPO7=1/1/1/1/1/1/1/1
T  TPO8=1/1/1/1/1/1/1/1
T  TPO9=1/1/1/1/1/1/1/1

```


NOTE * * * * *

NOTE

NOTE

RETIREMENT FLOWS

NOTE

NOTE * * * * *

A RET.K(GD,Q)=MEN.K(GD,Q+13)*RETN.K(GD,Q)*ATTRB.K(Q+13)

X *RETM.K*ATTP.K(GD)*ATMP.K(GD)*.25

A RETN.K(GD,Q)=MIN(4.0.RETC(GD,Q)+TEST4.K(GD,Q))

T RETC(*,1)=4.0/4.0/4.0/4.0/4.0/4.0/.495/.254/.152

T RETC(*,2)=4.0/4.0/4.0/4.0/4.0/4.0/4.0/.604/.369

A RETM.K=CLIP(1.0,FRETM.K,SMOOTH(CFDSC.K,4),CCFD)

C CCFD=-3500

A FRETM.K=TABHL(FRT,SMOOTH(CFDSC.K,4)/CCFD,1.0,2.0,.25)

T FRT=1/1/1/1/1

A TEST1.K=RAMP(CPQ,TSC)+RAMP(-CPQ,TSC+FCAT)

C TSC=0

C FCAT=0

C CPQ=0

A TEST2.K(GD)=0

A TEST3.K(GD,YR)=1+NN*NOISE()+STEP(DELA,ASTT)

C NN=0

C DELA=0

C ASTT=0

A TEST4.K(GD,Q)=0

A GPROF.K(GD)=SUMV(MEN.K(GD,*),1,OLD)

A YPROF.K(YR)=SUMV(MEN.K(*,YR),1,TOP)

A TRET.K=SUM(RET.K)

A TATT.K=SUM(ATT.K)

A TPR.K=SUM(PR.K)

A TOTF.K=SUM(MEN.K)

A P.K(1)=0

A P.K(GDU)=SUMV(PR.K(GDU,*),1,OLD)

NOTE * * * * *

NOTE

NOTE

CONSTANTS FOR INDEX COMPUTATIONS

NOTE

NOTE * * * * *

N IMW=IMWN

N CPI=CPIN

C PER=4

C CPIN=1

C AMP=0

C IMWN=1

C INF=.05

L CPI.K=CPI.J+DT*(IINF.JK)

R IINF.KL=INF*CPI.K*.25

A CWI.K=CPI.K*(1+AMP*SIN(6.28*TIME.K/PER))

L IMW.K=IMW.J+(MWI.JK)*DT

R MWI.KL=FMWI.K*IMW.K*.25

A FATT.K=SUMV(VATT.K(GD,*),1,8)/SUM(MEN.K)

A SATT.K=SMOOTH(FATT.K,8)

A FMWI.K=TABHL(TMWI,SATT.K,.0001289,.0009023,.0001289)

T TMWI=.05/.05/.05/.05/.05/.05/.05

NOTE * * * * *

NOTE

NOTE ACTIVE DUTY COSTS

NOTE

NOTE * * * * *

A $RC.K = (RCN * MFMPI.K + PCS) * ENLST.K$

L $RCR.K = RCR.J + DT * RC.J$

N $RCR = 140.32E6$

C $RCN = 942$

A $MFMPI.K = TABHL(TMPI, SMOOTH(IMW.K/CWI.K, 8), .5, 2.0, .25)$

T $TMPI = 1.2/1.05/1.0/.98/.96/.94/.9$

C $PCS = 821$

NOTE

NOTE

A $TRNC.K = ENLST.K * CPI.K * ACPT.K$

L $TRNCR.K = TRNCR.J + DT * TRNC.J$

N $TRNCR = 652.3E6$

A $ACPT.K = 8196$

NOTE

NOTE ACTIVE DUTY PAY

NOTE

A $ADPE1.K = SUMV(MEN.K(1, *), 1, OLD) * STPE1 * IMW.K * .25$

A $ADPE2.K = SUMV(MEN.K(2, *), 1, OLD) * STPE2 * IMW.K * .25$

A $ADPE3.K = SUMV(MEN.K(3, *), 1, OLD) * STPE3 * IMW.K * .25$

A $ADPE4.K = SUMV(MEN.K(4, *), 1, OLD) * STPE4 * IMW.K * .25$

A $ADPE5.K = SUMV(MEN.K(5, *), 1, OLD) * STPE5 * IMW.K * .25$

A $ADPE6.K = SUMV(MEN.K(6, *), 1, OLD) * STPE6 * IMW.K * .25$

A $ADPE7.K = SUMV(MEN.K(7, *), 1, OLD) * STPE7 * IMW.K * .25$

A $ADPE8.K = SUMV(MEN.K(8, *), 1, OLD) * STPE8 * IMW.K * .25$

A $ADPE9.K = SUMV(MEN.K(9, *), 1, OLD) * STPE9 * IMW.K * .25$

C $STPE1 = 6993$

C $STPE2 = 7750$

C $STPE3 = 8378$

C $STPE4 = 10349$

C $STPE5 = 11793$

C $STPE6 = 13857$

C $STPE7 = 16072$

C $STPE8 = 18517$

C $STPE9 = 21718$

NOTE

NOTE SEPARATION TRAVEL COSTS

NOTE

A $STC.K = SMOOTH(SUM(VATT.K) + SUM(FOA5.K), AST) * CPI.K * 715$

L $STCR.K = STCR.J + DT * STC.J$

N $STCR = 57.72E6$

A $TADP.K = ADPE1.K + ADPE2.K + ADPE3.K + ADPE4.K + ADPE5.K +$

X $ADPE6.K + ADPE7.K + ADPE8.K + ADPE9.K$

L $TADPR.K = TADPR.J + DT * TADP.J$

N $TADPR = 4956E6$

A $TOTCAF.K = RC.K + TRNC.K + TADP.K + STC.K$

L $TCAFR.K = TCAFR.J + DT * (RC.J + TRNC.J + STC.J + TADP.J)$

N $TCAFR = 5806.34E6$

NOTE * * * * *

NOTE

NOTE PRESENT RETIREMENT SYSTEM COSTS

NOTE

NOTE * * * * *

L RETL.K(GD,I)=RETL.J(GD,I)+DT*(RETR.JK(GD,I)-DR.JK(GD,I))

N RETL(GD,I)=VATT(GD,I+13)*ARTIME(GD,I)

R RETR.KL(GD,1)=RET.K(GD,14)

R RETR.KL(GD,2)=RET.K(GD,15)

R DR.KL(GD,I)=RETL.K(GD,I)/ARTIME(GD,I)

T ARTIME(*,1)=1/1/1/1/136/124/112/112/112

T ARTIME(*,2)=1/1/1/1/1/1/1/104/96

A TRP.K=SUM(RP.K)

L TRPR.K=TRPR.J+DT*TRP.J

N TRPR=1636.8E6

A RP.K(GD,I)=BP.K(GD,I)*RETL.K(GD,I)*YOS(GD,I)*.025

A BP.K(GD,I)=IBP(GD,I)*3

T IBP(*,1)=0/0/0/0/761/897/1088/1224/1388

T IBP(*,2)=0/0/0/0/0/0/0/1360/1523

T YOS(*,1)=0/0/0/0/20/23/26/26/26

T YOS(*,2)=0/0/0/0/0/0/0/28/30

A AATRP.K=SMOOTH(TRP.K,4)*4

NOTE

A TOTSC.K=TOTCAF.K+TRP.K

L TOTSCR.K=TOTSCR.J+DT*TOTSC.J

N TOTSCR=7443E6

A DTOTSC.K=TRP.K/(EXP(.02*.25*TIME.K))+TOTCAF.K/(EXP(.07*.25*TIME.K))

L DTSCR.K=DTSCR.J+DT*DTOTSC.J

N DTSCR=7443.14E6

NOTE

NOTE * * * * *

NOTE

NOTE PRESIDENT'S COMMISSION RETIREMENT SYSTEM COSTS

NOTE

NOTE * * * * *

L RETL.K(GD,I)=RETL.J(GD,I)+DT*(RETR.JK(GD,I)-DR.JK(GD,I))
N RETL(GD,I)=VATT(GD,I+10)*ANUTIME(GD,I)
R RETR.KL(GD,I)=VATT.K(GD,I+10)
R DR.KL(GD,I)=RETL.K(GD,I)/ANUTIME(GD,I)
T ANUTIME(*,1)=1/1/1/1/40/40/40/40/40
T ANUTIME(*,2)=1/1/1/1/40/40/40/40/40
T ANUTIME(*,3)=1/1/1/1/40/40/40/40/40
T ANUTIME(*,4)=1/1/1/1/48/48/48/48/48
T ANUTIME(*,5)=1/1/1/1/1/1/1/1/48/68
A TRP.K=SUM(ZRP.K)
L TRPR.K=TRPR.J+DT*TRP.J
N TRPR=790.96E6
A ZRP.K(GD,I)=BP.K(GD,I)*RETL.K(GD,I)*(.2125+.0275*(YOS(GD,I)-10))
A BP.K(GD,I)=IBP(GD,I)*3
T IBP(*,1)=0/0/0/0/721/789/884/1020/1182
T IBP(*,2)=0/0/0/0/748/830/911/1047/1209
T IBP(*,3)=0/0/0/0/761/856/979/1128/1293
T IBP(*,4)=0/0/0/0/761/897/1088/1224/1388
T IBP(*,5)=0/0/0/0/0/0/0/0/1360/1523
T IBPS(*,1)=0/0/0/632/666/734/830/0/0
T IBPS(*,2)=0/0/0/632/666/734/830/0/0
T IBPS(*,3)=0/0/0/632/694/761/856/992/0
T IBPS(*,4)=0/0/0/632/694/761/856/992/0
T IBPS(*,5)=0/0/0/0/721/789/884/1020/1182
T YOS(*,1)=11/11/11/11/11/11/11/11/11
T YOS(*,2)=12/12/12/12/12/12/12/12/12
T YOS(*,3)=13/13/13/13/15/15/16/18/18
T YOS(*,4)=0/0/0/0/20/23/26/26/26
T YOS(*,5)=0/0/0/0/0/0/0/0/28/30
A AATRP.K=SMOOTH(TRP.K,4)*4

NOTE

NOTE

NOTE DEFERRED COMPENSATION TRUST FUND

NOTE

NOTE

A DCTF1.K=BP1.K*SUMV(MEN.K(GD,*),6,10)*ZPCT1
A DCTF2.K=BP2.K*SUMV(MEN.K(GD,*),11,13)*ZPCT2
A DCTF3.K=BP3.K*MEN.K(GD,14)*ZPCT3
A DCTF4.K=BP4.K*MEN.K(GD,15)*ZPCT4
A BP1.K=694*3
A BP2.K=979*3
A BP3.K=1224*3
A BP4.K=1523*3
C ZPCT1=.20
C ZPCT2=.25
C ZPCT3=.15
C ZPCT4=.05
A TCDCTF.K=DCTF1.K+DCTF2.K+DCTF3.K+DCTF4.K
L TDCFR.K=TDCFR.J+DT*TCDCTF.J
N TDCFR=18216E3
A ACDCTF.K=SMOOTH(TCDCTF.K,4)*4

NOTE

NOTE

NOTE SEPARATION PAY

NOTE

NOTE

A SEPC.K(GD, I)=0
A SEPC.K(GD, J)=NVATT.K(GD, J)*IBPS(GD, J-5)*(J-5)*.25
A SEPC.K(GD, K)=NVATT.K(GD, K)*MIN(IBP(GD, K-10)*YOSN(GD)*.5,
X IBP(GD, K-10)*12)
A NVATT.K(4, 8)=AGE.K(4, 9)
A NVATT.K(5, 13)=AGE.K(5, 14)+FOUT.K(5, 13)
A NVATT.K(7, 14)=AGE.K(7, 15)+FOUT.K(7, 14)
A NVATT.K(GD, A)=0
A NVATT.K(B, 8)=0
A NVATT.K(C, 8)=0
A NVATT.K(F, D)=0
A NVATT.K(C, D)=FOUT.K(C, D)
A NVATT.K(F, G)=0
A NVATT.K(6, G)=0
A NVATT.K(7, 13)=FOUT.K(7, 13)
A NVATT.K(5, 14)=0
A NVATT.K(5, 15)=0
A NVATT.K(7, 15)=0
A NVATT.K(H, G)=FOUT.K(H, G)
A FOUT.K(F, YR)=0
A FOUT.K(GCR, YR)=RET.K(GCR, YR)-RET.K(GCR, YR)/RETM.K
T YOSN=0/0/0/0/11/12/20/26/30
A TSEPC.K=SUM(SEPC.K)
L TSEPCR.K=TSEPCR.J+DT*TSEPC.J
N TSEPCR=7189.6E3

NOTE

A TOTSC.K=TOTCAF.K+TRP.K+TCDCTF.K+TSEPC.K
L TOTSCR.K=TOTSCR.J+DT*TOTSC.J
N TOTSCR=6623.745E6
A DTOTSC.K=TOTCAF.K/(EXP(.07*.25*TIME.K))+(TRP.K+TCDCTF.K+TSEPC.K)/
X (EXP(.02*.25*TIME.K))
L DTSCR.K=DTSCR.J+DT*DTOTSC.J
N DTSCR=6623.7456E6

NOTE


```

NOTE
NOTE
NOTE
NOTE * * * * *
PLOT GPROF(1)=1/GPROF(2)=2/GPROF(3)=3/GPROF(4)=4
PLOT SLOTS(5)=5,GPROF(5)=+/SLOTS(6)=6,GPROF(6)=W/SLOTS(7)=7,
X GPROF(7)=X/SLOTS(8)=8,GPROF(8)=Y/SLOTS(9)=9,GPROF(9)=Z
PLOT TRET=R/TATT=A/ENLST=E(40000,120000)/TPR=P(100000,300000)
PLOT TOTF=T/ACARF=F,TCARF=C
PLOT CONR=C,PNHSE=N
PRINT 1)MEN(1,*)/2)MEN(2,*)/3)MEN(3,*)/4)MEN(4,*)/
X 5)MEN(5,*)/6)MEN(6,*)/7)MEN(7,*)/8)MEN(8,*)/9)MEN(9,*)/
X 10)YPROF(*)/11)GPROF(*),FORCE,TOTF,TCARF,DEMAND,SUPPLY,ENLST/
X 12)FATT,TATT,TRET,TPR/
X 14)REUP,FRETM,ENLSTM,FMWI
PRINT ATM(X,F)
PRINT FOA5
PRINT ATTRB
PRINT P
PRINT ATTP
PRINT ATTP,CONR,PNHSE
SPEC DT=.1/LENGTH=0/PLTPER=2
RUN ZWICK M=1
CP CPQ=-18380/TSC=4/FCAT=20
C FADT=1/FOD=-1
RUN DDATIM
C FOD=-1
T TMWI=.02/.03/.04/.05/.06/.08/.10
RUN DDMPM
C FOD=-1
T TPO5=1.2/1.1/1.05/1.0/.97/.90/.80
T TPO6=1.2/1.1/1.03/1.0/.97/.90/.80
T TPO7=1.15/1.1/1.03/1.0/.97/.90/.85
T TPO8=1.15/1.1/1.03/1.0/.97/.90/.85
T TPO9=1.10/1.05/1.02/1.0/.98/.95/.90
RUN DDPO

```


Vitae

John William Bell, Jr. was born 19 September 1948 in Oklahoma City, Oklahoma. He received his B.S. in Mathematics from Oklahoma Christian College in 1970 and entered navigator training at Mather Air Force Base, California. Upon completion of navigator training, he was assigned to the 11th Air Refueling Squadron at Altus Air Force Base, Oklahoma. In 1977 he entered the Air Force Institute of Technology as a candidate for Master of Science in Operations Research.

Permanent Address: 925 S.W. 65th
Oklahoma City, OK
73139

Robert E. Liphard was born 28 June 1947 in Baltimore, Maryland. He received his B.S. in Mathematics from Clemson University in 1969. His initial assignment was SAC HQ Offutt Air Force Base, Nebraska. In 1974 he was assigned to the Armament Development Test Center, Eglin Air Force Base, Florida as a weapon system simulation analyst. In 1977 he entered the Air Force Institute of Technology as a candidate for a Master of Science in Operations Research.

Permanent Address: 503 Cove Circle
Niceville, FL 32748

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AFIT/GOR/SM/78D-2	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A SYSTEM DYNAMICS MODEL OF THE DEPARTMENT OF DEFENSE ENLISTED FORCE FOR INVESTIGATION OF ALTERNATIVE RETIREMENT PROPOSALS		5. TYPE OF REPORT & PERIOD COVERED MS Thesis
7. AUTHOR(s) John W. Bell, Jr. Robert E. Liphard Captain USAF Captain USAF		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Air Force Institute of Technology (AFIT/EN) Wright-Patterson AFB, OH 45433		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Institute of Technology (AFIT/EN) Wright-Patterson AFB, OH 45433		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE December 1978
		13. NUMBER OF PAGES 177
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES Approved for public release; distribution unlimited Joseph P. Hipps, Major, USAF Director of Information 19 Jan 79		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Computer Simulation Enlisted Personnel System System Dynamics Retirement		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Several proposals to restructure the military retirement system have been placed before Congress and the Department of Defense. In order to evaluate the cost-effectiveness of these retirement proposals, each alternative must be considered in view of its impact on the entire personnel system. Consideration should be given to impacts on the force profile as well as to cost implications which result from changes in military compensation policies. Complex interactions occur in the personnel system which require a thorough understanding and investigation by force managers. This report develops a dynamic model of the		

DD FORM 1473

1 JAN 73

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Department of Defense enlisted personnel system which facilitates that type of examination. Analysis of the most recent retirement proposal, submitted by the resident's Commission on Military Compensation, indicates substantial savings could be realized under full implementation of the plan.



UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)